Making Connections

March 2015

Who will succeed and who will struggle? Predicting early college success with Indiana's Student Information System

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Key findings

- Half of Indiana's 2010 high school graduates who enrolled in a public state college that fall were successful according to three indicators of success: enrolled in only nonremedial coursework in the first semester, earned all attempted credits in the first semester, and persisted to a second year of college.
- College success differed by student demographic and academic characteristics, type of college (two year or four year), and indicator of college success.
- Although high school academic preparation and student behavior were related to indicators of college success, most of the variation in college success across students remains unexplained.

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REL 2015–078

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March 2015

This report was prepared for the Institute of Education Sciences (IES) under Contract ED-IES-12-C-0004 by Regional Educational Laboratory (REL) Midwest administered by American Institutes for Research. The content of the publication does not necessarily reflect the views or policies of IES or the U.S. Department of Education nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

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Stephan, J. L., Davis, E., Lindsay, J., & Miller, S. (2015). *Who will succeed and who will struggle? Predicting early college success with Indiana's Student Information System* (REL 2015–078). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Midwest. Retrieved from http://ies.ed.gov/ncee/edlabs.

This report is available on the REL website at http://ies.ed.gov/ncee/edlabs.

Summary

College success and career readiness have become major goals of education reform. Toward this end, Indiana policymakers have undertaken multiple efforts to prepare students for college. This study supports those efforts by describing the early college success of Indiana students, identifying measures in the state longitudinal data system that predict early college success, and examining the usefulness of those predictors.

Using data from the Indiana Student Information System, the state's longitudinal database, this study examined the early college success of Indiana's 2010 high school graduates who entered an Indiana two- or four-year public college in fall 2010. Because there is no widely accepted single indicator of early college success, the study adopted three commonly used indicators—enrolling in only nonremedial courses in the first semester, completing all attempted credits in the first semester, and persisting to a second year of college—plus a measure consisting of a composite of all three indicators. These individual indicators and their composite reflect achievements early in the college experience, and attaining these indicators suggests that a student entered a postsecondary institution ready for college. The study also identified variables for student demographic characteristics, high school academic achievement, and behavior that might be related to (or predict) whether a student achieves success in the early college years.

The study found that half the students achieved early college success by the composite of all three indicators. In addition, the analyses found:

- The percentage of students identified as achieving success varied by the indicator of success. Thus, using multiple measures of early college success may help capture different types of success.
- The gaps in early college success between Black students and White/other students (where "other" refers to any student not identified as Black, Hispanic, or White) were 13–27 percentage points. The gaps between students eligible for the school lunch program, a proxy for low-income status, and those not eligible were 14–22 percentage points.
- Having higher test scores and taking advanced coursework in high school predicted all three indicators of early college success as well as a composite of all three indicators, after controlling for other student and school characteristics.
- The number of student absences in high school predicted whether students attain all college-attempted credits in the first year and persist to a second year of college, as well as a composite of all three indicators. Taking the SAT or ACT predicted all three indicators as well as a composite of all three indicators among students entering two-year colleges but did not predict any indicators among students entering four-year colleges. The average academic achievement level of a student's high school also predicted these three indicators of early college success, but the predictive relationships were very small.
- Most of the variation across students in early college success was not explained by the examined predictors from the state longitudinal data system. Models based on the available data explained 35 percent or less of the variation in all of the examined indicators for students first entering a two-year college and 26 percent or less of the variation in indicators for students first entering a four-year college.

Results from this study will help the Indiana Commission for Higher Education advise Indiana high schools and colleges about readily available categories of student data that can distinguish students who are likely to succeed as soon as they reach college from students who are likely to struggle during their early years of college. More generally, results from this study can help educators and policymakers allocate resources to students who are most likely to struggle in college.

Contents

Summary i

Why this study? 1
Poor college completion rates have motivated interest in understanding early college success 1
Indiana policymakers want to improve students' early college success 1
Indiana two-year colleges are seeking to identify measures that can predict early college success 2

What the study examined 2

What the study found 6
Half the college student sample achieved early college success by the composite of all three individual indicators 6
The percentage of college students identified as achieving early college success varied by indicator and college type 7
The data indicate racial/ethnic, economic, and gender gaps in early college success 8
Academic preparation in high school predicts all indicators of early college success 9
Student behavior during high school predicts early college success 13
High school and college characteristics are not strong predictors of early college success 15
Most of the variation in early college success remains unexplained 15

Implications of the study 16
Consider targeting resources to specific subgroups of students 16
Consider using multiple indicators of early college success 16
Consider using multiple measures to predict early college success 16
Use caution in interpreting the significance of predictors of early college success 17

Limitations of the study 17

Appendix A. Literature review A-1

Appendix B. Data and methodology B-1

Appendix C. Additional results C-1

Notes Notes-1

References Ref-1

Boxes
1 Definition of early college success and indicators used in this study 3
2 Sample data 4
3 Indiana Core 40 diploma 5
B1 Selectivity of Indiana's 14 public four-year colleges, 2010 B-5

Figures
1 Students first entering a four-year college demonstrated more early college success than those first entering a two-year college, but success varied by indicator, 2010 college freshmen 7

2 The percentage of students achieving early college success varied by student race/ethnicity, 2010 college freshmen 9
3 The percentage of students achieving early college success varied by type of diploma earned, 2010 college freshmen 10
4 Students who earned at least one dual credit were more likely than students who earned no dual credits to achieve early college success by most indicators, 2010 college freshmen 12
5 Student absences were statistically significant predictors of three indicators of early college success, 2010 college freshmen 14
B1 Creation of the analytic samples B-2
C1 The percentage of students achieving early college success varied by eligibility for school lunch program, 2010 college freshmen C-6
C2 For a typical student first entering a two-year college, a one standard deviation increase in grade 10 ISTEP+ composite score is associated with a 33 percentage point increase in the predicted probability of enrolling in only nonremedial courses C-6
C3 For a typical student first entering a four-year college, a one standard deviation increase in grade 10 ISTEP+ composite score is associated with an increase of 13 percentage points in the predicted probability of being college ready by all indicators C-7
C4 Among students first entering a four-year college, students who took an Advanced Placement exam were more likely than students who did not take these exams to earn all attempted credits, persist to a second year, and have early college success by all indicators C-7
C5 Students first entering a two-year college who took the ACT or SAT were more likely than students who did not take these exams to have early college success by all indicators C-8
C6 Students first entering two-year colleges who took an AP exam were more likely than those who did not take any AP exams to have early college success by all indicators C-8

Tables

B1 Means of variables included in analysis for analytic sample B-7
B2 Rates of missing data in the analytic sample for the variables included in the analysis B-9
C1 Coefficients, standard errors, and statistical significance for models predicting early college success among students first entering a two-year college, 2010 college freshmen C-1
C2 Coefficients, standard errors, and statistical significance for models predicting early college success among students first entering a four-year college, 2010 college freshmen C-2
C3 Percentage of students who enrolled in only nonremedial courses and the percentage who earned all attempted credits, 2010 college freshmen C-3
C4 Percentage of students who enrolled in only nonremedial courses and the percentage who persisted to a second year, 2010 college freshmen C-3
C5 Percentage of students who earned all attempted credits and the percentage who persisted to a second year, 2010 college freshmen C-3
C6 Percentage of students demonstrating early college success by student subgroup, 2010 college freshmen C-4
C7 The examined predictors explained 35 percent or less of the variance in indicators of early college success, 2010 college freshmen C-5

Why this study?

College success and career readiness have become major goals of education reform (Council of Chief State School Officers, 2010; U.S. Department of Education, 2010). Toward that end, Indiana policymakers have undertaken multiple efforts to improve the success of high school graduates in their early college years. This study supports those efforts by describing the early college success of Indiana's 2010 high school graduates who entered a public Indiana college, identifying measures in the state longitudinal data system that predict early college success, and examining the usefulness of those predictors. Results from this study will help the Indiana Commission for Higher Education advise Indiana high schools and colleges about readily available categories of student data that can distinguish students who are likely to succeed as soon as they reach college from students who are likely to struggle during their early years of college. More generally, results from this study can help educators and policymakers allocate resources to students who are most likely to struggle in college.

This study describes the early college success of Indiana's 2010 high school graduates who entered a public Indiana college, identifies measures in the state longitudinal data system that predict early college success, and examines the usefulness of those predictors

Poor college completion rates have motivated interest in understanding early college success

Economic growth and prosperity increasingly require a workforce with a postsecondary education (Carnevale, Smith, & Strohl, 2010). Almost all seniors graduating from high school plan to attend college (Ingels, Planty, & Bozick, 2005), but not all students with college plans apply for, enter, or complete college. Overall, less than 60 percent of students who enter college attain a postsecondary credential: 57 percent of first-time, full-time degree seekers obtained their bachelor's degree in 2001, and 28 percent of students in a two-year college in 2005 completed a certificate or associate's degree within 150 percent of the normal time (National Center for Education Statistics, 2011, table 341).

To meet college requirements, more than one-third of first-time, full-time, degree-seeking college students enroll in at least one remedial course, defined as "instruction for a student lacking those reading, writing, or math skills necessary to perform college-level work at the level required by the attended institution" (National Center for Education Statistics, 2011, p. 730). Yet students who enroll in remedial courses earn postsecondary credentials at rates 15 percentage points lower than college students who are not required to enroll in a remedial course (Adelman, 2006; Attewell, Lavin, Domina, & Levey, 2006; see appendix A for details). Faced with this gap between college plans and college completion, states and high schools are seeking to better identify—and ultimately better prepare—students who may not be ready to succeed in college.

Indiana policymakers want to improve students' early college success

In July 2013 Indiana passed legislation requiring the Indiana State Board of Education, in consultation with other agencies, including the Commission for Higher Education, to create guidelines for high schools to use to identify students who may require remediation if they attend college or a postsecondary workforce training program (Postsecondary and Workforce Training Program Remediation Education Act, 2013). This effort builds on Indiana's work to align high school standards with workplace and college expectations (Plucker, Wongsarnpigoon, & Houser, 2006). For example, information from an analysis of gaps between Indiana's high school academic standards and college placement exams and employment practices was used in developing Indiana's Core 40 end-of-course assessments (Indiana ADP Action Team, 2006). The Core 40 graduation requirements were adopted in

2007 to increase the academic rigor of the high school curriculum (Indiana Department of Education, 2012).

Indiana two-year colleges are seeking to identify measures that can predict early college success

Remedial education is costly to states and students, and evidence of its effectiveness is mixed (see review in Bailey & Cho, 2010). Indiana is redesigning the structure of its remedial education system to reduce the number of students who enter the system and increase the success of those who do (Indiana Commission for Higher Education, 2012). As part of this redesign initiative, the Indiana Commission for Higher Education wants to provide information to two-year colleges about which high school measures predict students' early postsecondary achievements. Indiana's two-year colleges collect only a limited amount of data on students' high school achievement or other background characteristics and rely largely on standardized placement exams (for example, the Accuplacer) to identify students who may not be ready for college coursework. This study aims to determine the extent to which high school data could be useful in predicting which students will succeed in college. If such predictive relationships are found, the information can be used in conjunction with placement tests to determine which students to place in remedial coursework.

This study of early college success adopted three commonly used indicators and their composite: enrolling in only nonremedial courses in the first semester, completing all attempted credits in the first semester, and persisting to a second year of college

What the study examined

This study examined the early college success of Indiana's 2010 high school graduates who entered an Indiana two- or four-year public college in the fall after high school graduation. Because there is no widely accepted single indicator of early college success, this study adopted three commonly used indicators and their composite: enrolling in only nonremedial courses in the first semester, completing all attempted credits in the first semester, and persisting to a second year of college (box 1). These indicators demonstrate achievements in the early college years and suggest that a student entered a postsecondary institution ready for college. The study next looked for predictors in high school achievement, behavior, and demographic variables in Indiana's state longitudinal data system that might help educators spot students who need intervention to succeed in college. Separate results of regression analyses were produced for students who first entered a two-year college and those who first entered a four-year college.

This study aimed to answer the following research questions:

- What percentage of Indiana high school graduates who entered a public Indiana college arrived ready to succeed according to the three study indicators?
- Did the percentage of students showing early success in college vary by characteristics of students, their high school, or the college they attended?
- Did the percentage of students showing early success in college vary by the indicator of success being examined?

The study sample consisted of 32,564 students who graduated from one of 414 public or private high schools in Indiana in 2010 and attended one of Indiana's 29 public colleges in fall 2010 (box 2).

To address the first research question, about what percentage of Indiana high school graduates entered a public Indiana college ready to succeed, the study calculated the percentage of students achieving the three indicators of early college success and their composite.

Box 1. Definition of early college success and indicators used in this study

The term "early college success" as used in this report is conceptually similar to the definition of "college readiness" used by other researchers: the level of preparation needed to enroll and succeed in credit-bearing college courses (Achieve Inc., 2013; ACT Inc., 2007; Conley, 2011). However, there is no widely agreed-on indicator of whether a student is succeeding in college (see appendix A for a summary of indicators of early college success in prior research). To address limitations in any one indicator, this study examined three indicators related to early college success as well as a composite of all three indicators, all of which offer direct evidence of whether a student was prepared for the rigors and demands of college:

- *Whether students enrolled in only nonremedial courses.* Early college success is evident when a student is not required to enroll in a remedial course (math or English) in the first semester of college (fall 2010 for this study). Students who enroll in a remedial college course are, by definition, not academically prepared for all college coursework. In addition, this indicator is aligned closely with Indiana legislation requiring high schools to identify students who may be heading for remediation after high school.[1] In Indiana, remedial courses are offered primarily at two-year colleges, and therefore students who enter a two-year college will have higher remediation rates.
- *Whether students earned all attempted credits.* Early college success is also evident if a student earned all attempted credits (remedial or not) in the first semester of college (fall 2010). Students who did not earn all attempted credits include students who failed a course (earned less than a D– or failed a pass/fail course), those who withdrew late, and those who received a grade of incomplete.[2]
- *Whether students persisted to a second year.* Early college success is displayed when a student who entered a public Indiana college in fall 2010 was still attending any college (public, private, in state, or out of state) in fall 2011. This indicator is consistent with the commission's definition of persistence. Although this indicator is more distal from high school than the first two measures are, it may ultimately be more important to policymakers because it is a first step on the path to degree completion.
- *Whether students attained college success by all three indicators.* This composite measure indicates early college success if a student is identified as achieving success by all three indicators: enrolling in only nonremedial courses in the first semester, earning all attempted credits in the first semester, and persisting to the second year.

Notes

1. This indicator can be problematic because institutions have different remedial education policies: a student considered ready for college at one institution may not be considered ready at another. This institutional specificity may also apply to the other two indicators of early college success and to the composite of all three indicators. Ivy Tech Community College, Indiana's system of public two-year colleges, bases remedial education placement on four factors: ACT, SAT, or PSAT score; high school GPA; previous college coursework; and the Accuplacer assessment (Ivy Tech Community College, n.d.). Grade 10 Indiana Statewide Testing for Educational Progress—Plus composite scores were highly correlated with scores on the ACT (0.85) and SAT (0.86) for students in the analytic sample.

2. This definition does not account for the rigor of the courses or the number of attempted credits. Students who attend part time could do so for multiple reasons that are unrelated to early college success (such as family responsibilities or employment). This indicator focuses on students' preparation for the courses they choose to attempt. Investigating enrollment intensity is outside the scope of this analysis (see Bozick & DeLuca, 2005; Chen & Carroll, 2007; and McCormick, Geis, & Vergun, 1995 for discussions of part-time enrollment).

Box 2. Sample data

The full sample consisted of 32,564 students who graduated from one of 414 public or private high schools in Indiana in 2010 and attended one of Indiana's 29 public colleges in fall 2010. These students were primarily White (83 percent) with smaller percentages of students who were Black (9 percent), Hispanic (4 percent), or Asian (2 percent). Some 54 percent of the students were female, and 22 percent were eligible for the school lunch program (that is, eligible for free or reduced price lunch, which is used here as a proxy for low-income status). And 39 percent of students in the full sample earned a Core 40 diploma with honors (box 3). Of the students in the sample, 9,812 entered a two-year college, and 22,752 entered a four-year college in fall 2010. (Appendix B contains more information on the sample.) The study examines only students who both graduated from high school in Indiana in spring 2010 and entered a public Indiana college in fall 2010. The sample does not include students who graduated in spring 2010 and delayed college enrollment or students who transferred to a public Indiana college in fall 2010. This focus on high school graduates' early college success during their first year of college differs from another common approach to studying college success: tracking college completion rates over one or more institutions. To make this distinction clear, the caveat "in graduates' first post-secondary institution" is repeated throughout the presentation of the findings.

Two methods were used to address the second research question, on whether students arriving at public Indiana colleges ready to succeed varied by student, high school, or college characteristics. In the first method, success rates were examined by indicator and by tabulating percentages of students achieving each of the four indicators by student subgroup and calculating the correlation between student and school characteristics. In the second method, the relationships between student characteristics and each of the indicators were examined after controlling for the other possible predictors (the specifics of the statistical models are in appendix B).

The student- and school-related predictors used in the models included:[1]

- *Demographic and socioeconomic characteristics.* Race/ethnicity (Black, Hispanic, and White/other; see appendix B), gender, and eligibility for the school lunch program.
- *Academic preparation.* Grade 10 Indiana Statewide Testing for Educational Progress—Plus (ISTEP+) math and English language arts composite scores, earning at least one dual credit, taking at least one Advanced Placement (AP) exam (for students first entering a two-year college),[2] taking and passing at least one AP exam, and taking but not passing at least one AP exam (for students first entering a four-year college; see appendix B for more detail).
- *Behavior.* An indicator of taking a college admission exam (SAT or ACT) and indicators for high school absences (15–30 absences or 31 or more absences between 2006–07 and 2009–10, the cutoff points for the middle third and upper third of absences among all 2010 Indiana high school graduates).

The regression models also included the following high school and college characteristics:

- *High school characteristic.* The school percentage of grade 10 students who passed the English end-of-course assessment in 2010, which indicates the achievement level of a student's high school peers.

Box 3. Indiana Core 40 diploma

In 2005 the Indiana State Board of Education adopted new course and credit requirements (the Core 40 curriculum) for earning a high school diploma. The Core 40 curriculum aims to provide the "academic foundation all students need to succeed in college, apprenticeship programs, military training and the workforce" (Indiana Department of Education, 2012). Beginning with students entering high school in 2006/07 (corresponding to the 2010 graduating class, from which the students in the study come), Indiana high school students had the option to earn one of four types of diplomas (general, Core 40, Core 40 with academic honors, and Core 40 with technical honors; see Indiana Department of Education, 2006, for the specific requirements) or an International Baccalaureate diploma for students attending high schools with International Baccalaureate programs. The board encouraged these students to earn a Core 40 diploma or higher (Indiana State Board of Education, 2006). In the following year (for students entering high school in 2007/08), the Core 40 curriculum became a requirement for graduation (with a formal opt-out provision allowing students to earn a general diploma with parental consent). In fall 2011, four-year public Indiana colleges began requiring Core 40 for admissions (Indiana State Board of Education, 2006).

For this analysis, students who earned a Core 40 diploma with academic honors were combined with students who earned a Core 40 diploma with technical honors and with students who completed an International Baccalaureate diploma. In the analytic sample, 37 percent of students completed a Core 40 diploma with academic honors, 0.8 percent completed a Core 40 diploma with technical honors, 0.6 percent completed a Core 40 diploma with both technical and academic honors, and 0.2 percent completed an International Baccalaureate diploma.

- *College selectivity.* Four-year colleges were classified into three categories based on the Barron's selectivity ranking, which is based on the academic qualifications of students at the college and the percentage of applicants accepted (Barron's Educational Series, 2010). For the analysis, the Barron's categories were collapsed to three: less competitive, competitive, and more competitive. (See box B1 in appendix B for a list of institutions in each category.)[3]

To answer the third research question, on whether the percentage of students showing early success in college varied by the indicator of success being examined, the results of hierarchical logistic regression models were compared. There were four models, one for each of the three individual indicators and one for the composite of all three indicators, for students first entering a two-year college and four models for students first entering a four-year college. Because two- and four-year college students differ on several dimensions, including academic achievement, socioeconomic status, persistence, degree completion, and remedial education, models were estimated separately by college type. The predictive value of models was determined by creating statistical models containing student characteristics, high school characteristics, and college selectivity measures of early college success.

To help readers interpret the results, the change in the predicted probability of early college success associated with a unit change in a predictor is presented for a "typical" student in the sample. Presenting results for a typical student is made possible by centering the predictors about their overall means, separately for students who first enter a two-year college and for students who first enter a four-year college. The term "typical" thus represents an

average student in the analytic samples. (See appendix B for a discussion of the predicted probability calculation and appendix C for detailed findings.)

What the study found

The goal of this study was to examine relationships between characteristics of high school graduates and their high schools and the early college success of those graduates. The analyses used to address the research questions revealed six main findings:

- Overall, 92 percent of students were successful during their early college years by at least one indicator. Across the composite of all three indicators, 50 percent demonstrated early college success.
- Students entering a four-year college demonstrated more early success than those entering a two-year college, but success varied by indicator.
- All the differences by race/ethnicity favored students who were classified as White/other. Black students showed the largest gap when compared with White/other students.
- Students who were not eligible for school lunch programs demonstrated more early college success by all indicators than students who were eligible for school lunch programs.
- Academic preparation in high school predicted all indicators of early college success.
- Student behavior and the achievement level of the high school predicted some indicators of early college success.
- The selectivity of the college a student attends did not predict early college success.
- Most of the variation in early college success remains unexplained by data in the state longitudinal data system.

The analysis identified multiple predictors of students' early college success, including students' demographic characteristics, high school academic preparation, behavior, and high school and college context, but none explained more than 35 percent of the variation in students' early college success

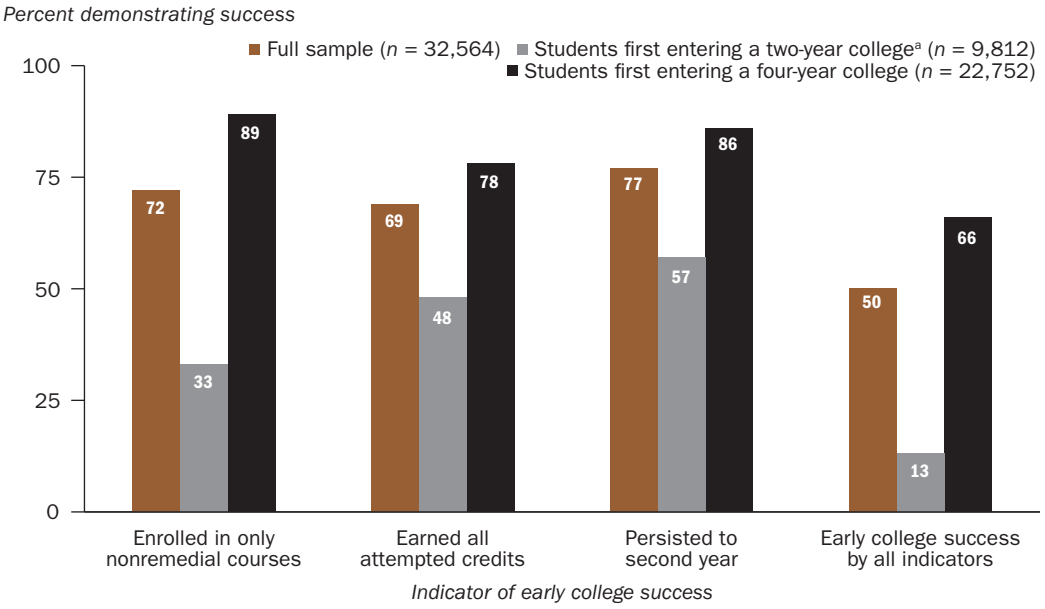
This analysis identified multiple predictors of students' early college success, including students' demographic characteristics, high school academic preparation, behavior, and high school and college context. (Unless otherwise noted, all reported regression results are statistically significant.) However, none of these characteristics explained more than 35 percent of the variation in students' early college success (see table C7 in appendix C). For students first entering a two-year college, the models explained 35 percent or less of the variation in all four indicators, while for students entering a four-year college, the models explained 26 percent or less of the variation.

That so much of the variance remains unexplained may indicate that these data elements are imperfect predictors of early college success. Educators and policymakers need to exercise caution in using them to identify students who may not be ready for college. Factors not currently captured by state data (for example, social or emotional factors) could be researched to potentially explain additional variation.

Half the college student sample achieved early college success by the composite of all three individual indicators

Overall, 92 percent of students were successful during their early college years by at least one indicator. Across the composite of all three indicators, however, this share drops to 50 percent (figure 1), with students first entering a two-year college less likely to achieve

Figure 1. Students first entering a four-year college demonstrated more early college success than those first entering a two-year college, but success varied by indicator, 2010 college freshmen



a. Includes Vincennes University, a four-year college that has an open-admissions policy and that grants primarily associate's degrees.

Note: Percentages are unadjusted and do not account for student, high school, or background characteristics.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Students first entering a two-year college were less likely to achieve early college success than students who first entered a four-year college

early college success (13 percent) than students who first entered a four-year college (66 percent).

The well documented differences in high school academic preparation between students who first enter a two-year college and those who first enter a four-year college were also found in this sample of Indiana college students (Plank & Jordan, 2001; Stephan, Rosenbaum, & Person, 2009). Students who first entered a two-year college took AP exams at lower rates than students who first entered a four-year college (9 percent and 46 percent), passed AP exams at lower rates (1.5 percent and 20 percent), and earned at least one dual credit at lower rates (13 percent and 18 percent; see table B1 in appendix B). Students who first entered a two year college also had lower grade 10 ISTEP+ composite scores than students who first entered a four-year college.[4] These findings suggest that a key to improving the early college success for Indiana college students involves an increased focus on students who first enter a two-year college.

The percentage of college students identified as achieving early college success varied by indicator and college type

Overall, 72 percent of students enrolled in only nonremedial courses in the first semester, 69 percent earned all attempted credits in the first semester, and 77 percent persisted to a second year (see figure 1). These percentages were lower and more varied among students first entering a two-year college. Of those students, 33 percent enrolled in only nonremedial courses, which partly reflects Indiana's policy to offer remedial courses primarily at

two-year colleges. Some 48 percent of students first entering a two-year college earned all attempted credits, and 57 percent persisted to a second year. Among students first entering a four-year college, 89 percent enrolled in only nonremedial courses, 78 percent earned all attempted credits, and 86 percent persisted to a second year. Differences by college type are most prominent for the composite variable: 13 percent of students first entering a two-year college attained the composite of all three indicators compared with 66 percent of students first entering a four-year college. Although indicators of early college success are positively related to each other, achieving early college success by one indicator was not a guarantee of achieving early college success by other indicators (see tables C3–C5 in appendix C).

The data indicate racial/ethnic, economic, and gender gaps in early college success

Double-digit gaps in early college success were found between Black students and White/other students, between Black students and Hispanic students, and between students who were eligible for the school lunch program in high school and students who were not eligible

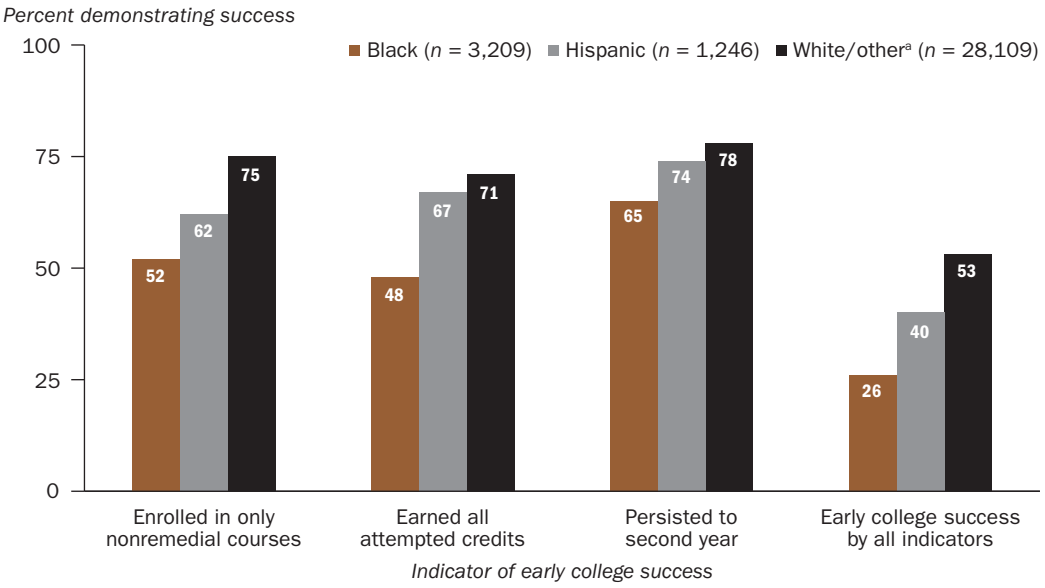
Double-digit (unadjusted) gaps in early college success were found between Black students and White/other students (differences of 13–27 percentage points), between Black students and Hispanic students (9–19 percentage points), and between students who were eligible for the school lunch program in high school and students who were not eligible (14–22 percentage points; see table C6 in appendix C). Smaller gaps were found between White/other students and Hispanic students and between male and female students. Adjustments for differences in students' other background characteristics and high school and college context account for some of the differences in early college success between demographic groups; however, most comparisons remained statistically significant (see tables C1 and C2 in appendix C).

Race/ethnicity. Overall, students categorized as White/other showed more indication of early college success than Hispanic students, who showed more indication of early college success than Black students (figure 2). This was true for those enrolling in only nonremedial courses (75 percent for White/other students, 62 percent for Hispanic students, and 52 percent for Black students), those earning all attempted credits (71 percent for White/other students, 67 percent for Hispanic students, and 48 percent for Black students), and those persisting to a second year of college (78 percent for White/other students, 74 percent for Hispanic students, and 65 percent for Black students).

None of the gaps between Hispanic students and White/other students remained after adjusting for differences in student, high school, and college characteristics (such as school lunch program eligibility, high school academic preparation, behavior, high school academic achievement, and college selectivity; see regression model results in tables C1 and C2 in appendix C). However, background differences did not account for the gaps between Black students and White/other students. Among students first entering a four-year college, the gap was 8 percentage points for earning all attempted credits and 7 percentage points for the early college success composite. Among students first entering a two-year college, the gap was 14 percentage points for earning all attempted credits, 7 percentage points for persisting to a second year, and 4 percentage points for achieving all indicators of success, after accounting for other student, high school, and college characteristics. All the racial/ethnic differences favored students who were classified as White/other (see table C6 in appendix C).

Students' eligibility for the school lunch program in high school. Double-digit (unadjusted) gaps were found in early college success based on students' eligibility for the school

Figure 2. The percentage of students achieving early college success varied by student race/ethnicity, 2010 college freshmen



a. Includes students who are White (95 percent of students), Asian (2 percent of students), or Native American/Alaska Native (0.2 percent of students) and students of two or more races/ethnicities (3 percent of students).

Note: Percentages are unadjusted and do not account for student, high school, or background characteristics.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Overall, students categorized as White/other showed more indication of early college success than Hispanic students, who showed more indication of early college success than Black students

lunch program (see figure C1 in appendix C). Students eligible for the school lunch program enrolled in only nonremedial courses at a rate of 58 percent, which was 18 percentage points lower than the rate for students who were not eligible. Students eligible for the school lunch program earned all attempted credits at a rate of 56 percent, 17 percentage points lower than the rate for students who were not eligible, and persisted to a second year at a rate of 66 percent, 14 percentage points lower than the rate for students who were not eligible.

After adjustments for other student, high school, and college characteristics, the gap between students eligible and not eligible for the school lunch program was no longer statistically significant for enrolling in only nonremedial courses; however, the gaps remained statistically significant but smaller for earning all attempted credits, persisting to the second year, and the early college success composite. Students eligible for the school lunch program who first entered a two-year college were 3 percentage points less likely to earn all attempted credits, 5 percentage points less likely to persist to a second year, and 2 percentage points less likely to attain all indicators of early college success. Among students first entering a four-year college, gaps also remained for earning all attempted credits (4 percentage points) and persisting to a second year (3 percentage points), as well as for the college success composite (6 percentage points; see tables C1 and C2 in appendix C for specific findings).

Academic preparation in high school predicts all indicators of early college success

The type of high school diploma that Indiana students earn predicts early college success. Indiana offers four types of high school diplomas: general, Core 40, Core 40 with academic honors, and Core 40 with technical honors (see box 3). Among 2010 high school

graduates who entered a public Indiana college in the fall after high school, 10 percent earned a general diploma, 51 percent earned a Core 40 diploma, and 39 percent earned a Core 40 diploma with technical or academic honors (see table B1 in appendix B).

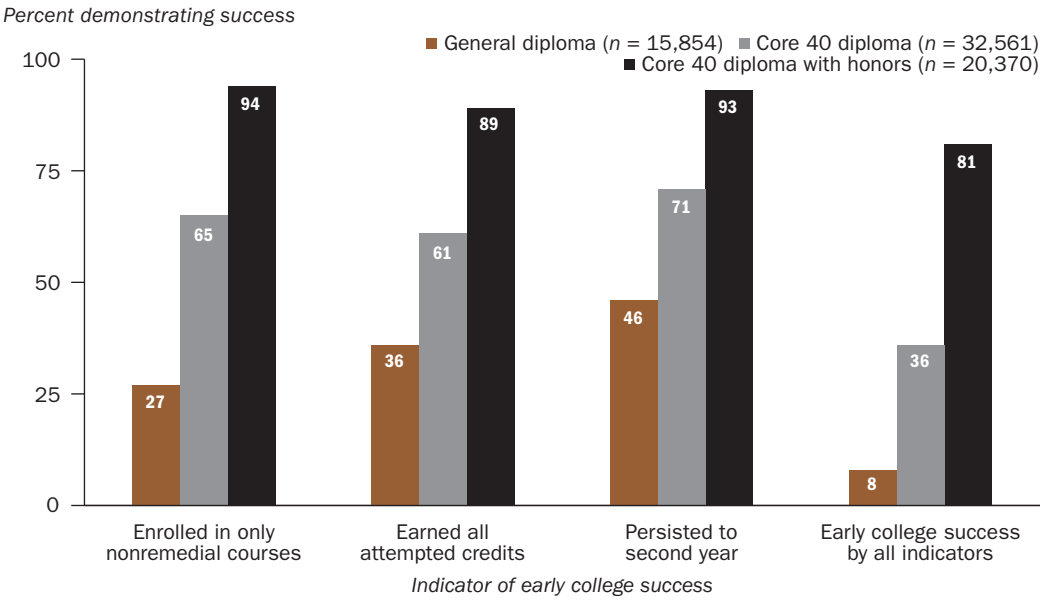
Overall, 81 percent of students who earned a Core 40 diploma with honors achieved early college success by all individual indicators, compared with 36 percent of students who earned a Core 40 diploma without honors (figure 3). Moreover, 65 percent of students who earned a Core 40 diploma without honors enrolled in only nonremedial courses, 61 percent earned all attempted credits, and 71 percent persisted to a second year of college. In comparison, a greater percentage of students earning the Core 40 diploma with honors enrolled in only nonremedial courses (94 percent), earned all attempted credits (89 percent), and persisted to a second year (93 percent).

Overall, 81 percent of students who earned a Core 40 diploma with honors achieved early college success by all individual indicators, compared with 36 percent of students who earned a Core 40 diploma without honors

Of the 10 percent of students who entered college after earning the general diploma, only 8 percent achieved early college success by all individual indicators (see figure 3). Some 27 percent of students who earned a general diploma enrolled in only nonremedial courses, 36 percent earned all attempted credits, and 46 percent persisted to a second year. These findings suggest that attaining a Core 40 diploma is not a guarantee of early college success, but that students attaining this diploma were more likely than students who received the general diploma to attain early college success.

Although diploma type was not included in the regression analyses, two criteria for the Core 40 diploma are students' test scores and advanced coursework. These two measures predict all three indicators of early college success and the composite of all three indicators (see tables C1 and C2 in appendix C).

Figure 3. The percentage of students achieving early college success varied by type of diploma earned, 2010 college freshmen



Note: Percentages are unadjusted and do not account for student, high school, or background characteristics.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

The predictive value of grade 10 ISTEP+ composite scores differed between students who first entered a two-year college and those who first entered a four-year college. Among students first entering a two-year college, grade 10 ISTEP+ composite scores appeared to be a better predictor of whether students would enroll in only nonremedial courses than of other individual indicators of early college success (figure C2 in appendix C).

For the typical student first entering a two-year college, a one standard deviation increase in grade 10 ISTEP+ composite scores[5] was associated with an increase of 33 percentage points in the predicted probability of enrolling in only nonremedial courses, but a 3 percentage point increase in the predicted probability of earning all attempted credits and a 2 percentage point increase in persisting to a second year. The relatively strong relationship between the grade 10 ISTEP+ composite score and enrollment in only nonremedial courses may reflect the use of test scores (ACT, SAT, or Accuplacer) for determining remedial placement.

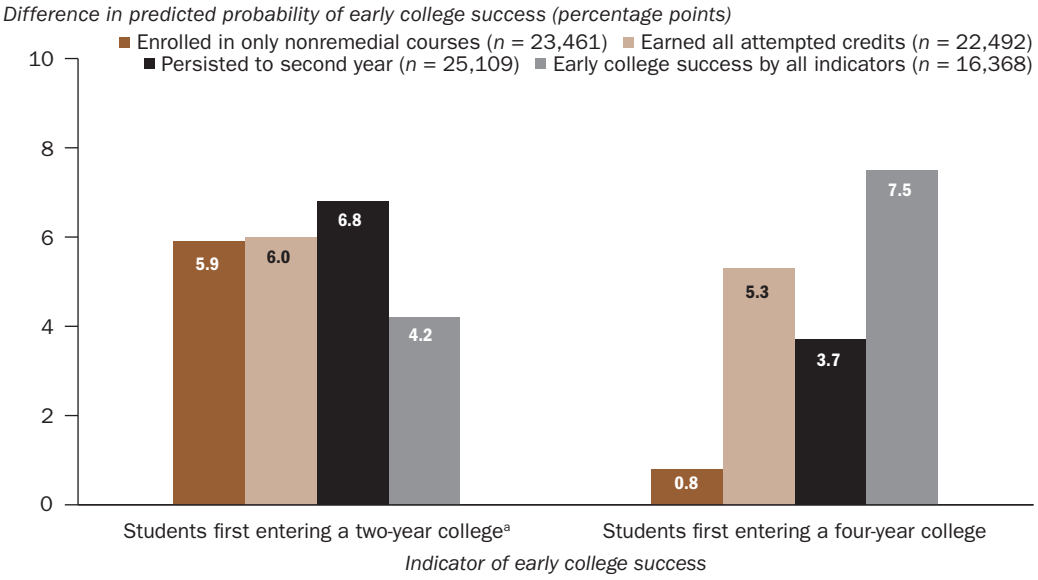
Taking an AP exam was associated with higher levels of early college success for all individual indicators

For the typical student first entering a four-year college, a one standard deviation increase in grade 10 ISTEP+ composite scores was associated with a 6 percentage point increase in the predicted probability of earning all attempted credits and 2 percentage point increases in enrolling in only nonremedial courses and in persisting to a second year (see figure C3 in appendix C). The relationship between test scores and enrolling in only nonremedial courses was relatively strong for both students first entering a two-year college and students first entering a four-year college. However, this relationship was weaker for students first entering a four-year college (see regression model results in tables C1 and C2 in appendix C).

Advanced coursework in high school predicts early college success. Students who participated in advanced coursework (took dual-credit courses or took AP exams) had higher levels of early college success on average than students who did not. Some 13 percent of students who first entered a two-year college and 18 percent of students who first entered a four-year college had earned at least one dual credit (see table B1 in appendix B). For the typical student first entering a two-year college, earning at least one dual credit was associated with a 5.9 percentage point increase in the predicted probability of enrolling in only nonremedial courses, a 6 percentage point increase in earning all attempted credits, a 6.8 percentage point increase in the predicted probability of persisting to a second year, and a 4.2 percentage point increase in the composite early college success measure (figure 4). For the typical student who first entered a four-year college, earning at least one dual credit was associated with a 5.3 percentage point increase in earning all attempted credits, a 3.7 percentage point increase in persisting to a second year, and a 7.5 percentage point increase for the composite early college success measure. Earning at least one dual credit was associated with an increase of less than 1 percentage point in the predicted probability of enrolling in only nonremedial courses for the typical student who first enters a four-year college (see figure 4).

Taking an AP exam was associated with higher levels of early college success for all individual indicators. Some 46 percent of students first entering a four-year college had taken at least one AP exam, but less than half of these students (44 percent) had passed one. However, regardless of whether students passed, taking an AP exam was associated with students' increased early college success. For the typical college student who first enters a four-year college, taking at least one AP exam but not passing any was associated with an increase in the predicted probability of earning all attempted credits (7.7 percentage points),

Figure 4. Students who earned at least one dual credit were more likely than students who earned no dual credits to achieve early college success by most indicators, 2010 college freshmen



a. Includes Vincennes University, a four-year college that has an open-admissions policy and that grants primarily associate's degrees.

Note: The difference in predicted probabilities accounts for student academic, demographic, and behavioral characteristics; high school academic characteristics; and college type and selectivity characteristics. The number of students achieving early college success by college type breaks down as follows. For students first entering a two-year college (n = 9,812), 3,204 students enrolled in only nonremedial courses, 4,731 earned all attempted credits, 5,546 persisted to a second year, and 1,284 earned early college success by all indictors. For students first entering a four-year college (n = 22,752), 20,257 students enrolled in only nonremedial courses, 17,761 earned all attempted credits, 19,563 persisted to a second year, and 15,084 earned early college success by all indicators.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

persisting to a second year (5.4 percentage points), and early college success as defined by the composite of all three indicators (11.3 percentage points; figure C4 in appendix C) compared with not taking any AP exams. Moreover, for students first entering a four-year college, taking and passing at least one AP exam was associated with increases in the predicted probability of earning all attempted credits (3.7 percentage points), persisting to a second year (3.5 percentage points), and early college success by all individual indicators (5.2 percentage points) compared with taking and not passing an AP exam. The relationship between taking an AP exam and enrolling in remedial coursework is weaker than the relationships with other indicators of early college success: taking and passing at least one AP exam was associated with a 2 percentage point increase in the predicted probability of enrolling in only nonremedial courses compared with not taking an AP exam.

Some 9 percent of students first entering a two-year college had taken at least one AP exam, and 1.5 percent had passed at least one AP exam. For the typical student first entering a two-year college, taking at least one AP exam (compared with not taking one) was associated with increases in the predicted probability of enrolling in only nonremedial courses (14 percentage points), earning all attempted credits (8 percentage points), persisting to a second year (7 percentage points), and achieving the early college success composite measure (6 percentage points; see figure C6 in appendix C).

The relationship between taking advanced coursework and early college success may not be causal. The analyses performed for this study cannot determine whether taking an advanced course causes students to succeed during their early college years. Students who choose to enroll in advanced courses may be students who would be more likely to achieve early success in college regardless of whether they enrolled in advanced courses. That is, students with a strong commitment to attaining a college degree may be more likely to enroll in advanced coursework in high school and also more likely to persist to a second year of college, regardless of whether they take advanced coursework in high school. Among students first entering a two-year college, those who took an AP exam (just 9 percent) may be an especially unusual group. Because so few 2010 graduates first entering a two-year college passed an AP exam, analyses do not differentiate between taking and not passing this exam versus taking and passing it.

Student behavior during high school predicts early college success

Having few high school absences predicts early college success. Consistent with prior research, high school absences (total days absent between 2006/07 and 2009/10) were found to predict three indicators of first-year college success: the likelihood of completing all attempted credits, the likelihood of persisting to a second year, and the likelihood of early college success more generally (the composite measure; figure 5).

For a typical student first entering a two-year college, having 15–30 absences in high school compared with having fewer than 15 absences was associated with a 9.7 percent decrease in the predicted probability of earning all attempted credits

For a typical student first entering a two-year college, having 15–30 absences in high school compared with having fewer than 15 absences was associated with a 9.7 percent decrease in the predicted probability of earning all attempted credits, a 7.3 percent decrease in the predicted probability of persisting to a second year, and a 2.2 percent decrease in the predicted probability of achieving early college success as measured by the composite of all three indicators. Among students first entering a four-year college, having 15–30 absences was associated with a 5.8 percent decrease in the predicted probability of earning all attempted credits, a 4.3 percent decrease in the predicted probability of persistence, and an 8.3 percent decrease in the predicted probability of achieving the early college success composite measure compared with having fewer than 15 absences.

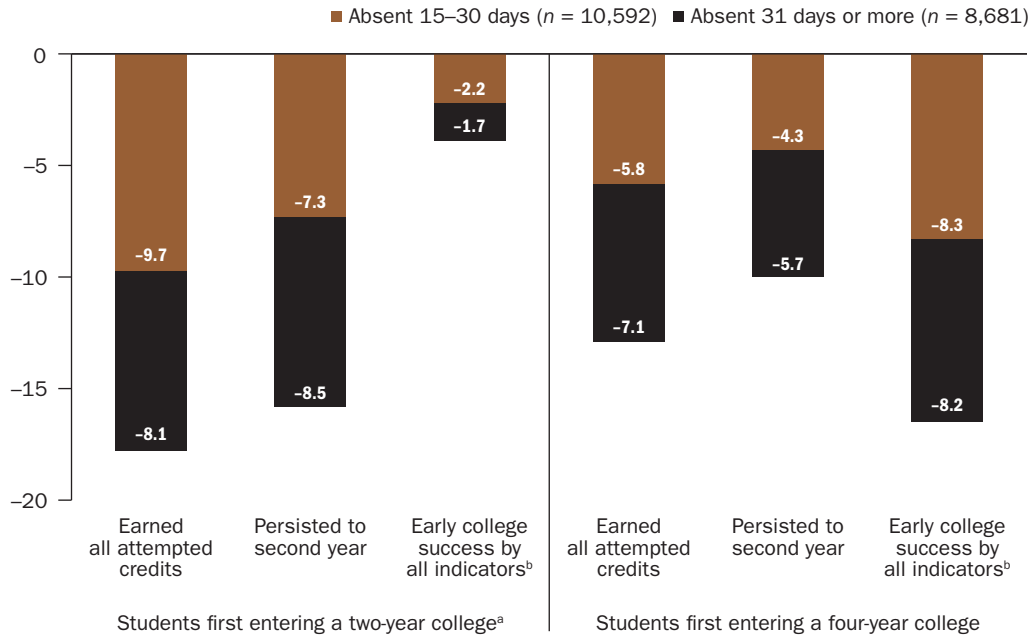
Among students first entering two-year colleges and students first entering four-year colleges with 31 or more absences in high school, the differences in the predicted probability of earning all attempted credits, persisting to a second year in college, and attaining all three indicators (the composite) were about double the differences for students with 15–30 absences.

The number of absences that students had in high school was not a statistically significant predictor of the likelihood of enrolling in all nonremedial courses (see the corresponding regression model results in tables C1 and C2 in appendix C). Having 31 absences corresponds to the upper third cutoff point in the distribution of high school absences among all 2010 Indiana high school graduates.

Taking the SAT or ACT predicts early college success. Completing key college enrollment actions predicts college attendance and may reflect a student's college knowledge, commitment to pursuing postsecondary education, or interest in attending or transferring to a four-year college (see appendix A). This analysis examined one college enrollment action—whether the student ever took the SAT or ACT—and found that it related to

Figure 5. Student absences were statistically significant predictors of three indicators of early college success, 2010 college freshmen

Difference in predicted probability of early college success compared with having fewer than 15 absences (percentage points)



Note: The difference in predicted probabilities accounts for student academic, demographic, and behavioral characteristics; high school academic characteristics; and college type and selectivity characteristics. Percentage points in the brown portions of the bars represent the additional percentage point differences in the predicted probability of each outcome for students with 31 or more absences beyond the predicted probability of each outcome for those with 15–30 absences compared with students with fewer than 15 absences. The number of students absent 15–30 days and 31 days or more by college type breaks down as follows: for students first entering a two-year college (n = 9,812), 3,109 students were absent 15–30 days, and 3,572 were absent 31 days or more. For students first entering a four-year college (n = 22,752), 7,483 students were absent 15–30 days, and 5,109 were absent 31 days or more.

a. Includes Vincennes University, a four-year college that has an open-admissions policy and that grants primarily associate's degrees.

b. The composite variable indicating a student achieved early college success by enrolling in only nonremedial coursework, earning all attempted credits, and persisting to a second year.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Among students first entering two-year colleges and students first entering four-year colleges with 31 or more absences in high school, the differences in the predicted probability of earning all attempted credits, persisting to a second year in college, and attaining all three indicators were about double the differences for students with 15–30 absences

all individual indicators of early college success and their composite for students who first entered a two-year college (all p-values less than .001; figure C5 in appendix C), but it did not relate to early college success for students who first entered a four-year college (average p-value = .18).

Half of students (52 percent) first entering a two-year college and 83 percent of students first entering a four-year college took the SAT or ACT (see table B2 in appendix B). Students who first entered a two-year college and took the SAT or ACT were more likely than students who first entered a two-year college without taking one of the exams to enroll in only nonremedial courses (6.6 percent more likely), earn all attempted credits (4.2 percent), persist to a second year of college (10.9 percent), and achieve early college success as measured by the composite of all three indicators (3.1 percent; see figure C5 in appendix C). States have increasingly made college admissions exams part of statewide testing.[6] This analysis cannot show whether increasing the number of students who take

a college admissions exam will increase early college success. But it does show that among students who entered a two-year college, those who voluntarily took a college admissions exam were more likely to achieve success on multiple indicators.

High school and college characteristics are not strong predictors of early college success

The average academic achievement of students' high schools has limited predictive value. Prior research suggests that high school context, including the average achievement level of students within a high school, relates to individual achievements (see appendix A). This analysis finds that one measure of peer knowledge, the percentage of students within a high school who passed the English end-of-course exam in 2010, predicts multiple indicators of early college success. However, the relationships, although statistically significant, are not strong enough to warrant much attention. Case in point: among students first entering a two- or four-year college, a 5 percentage point increase in the school percentage of grade 10 students passing the English end-of-course exam was associated with an increase of 1 percentage point in the predicted probability of earning all attempted credits, persisting to a second year, or achieving early college success according to the composite measure. An increase of 5 percentage points in the number of students passing the end-of-course exam was associated with a 1 percentage point increase in enrolling in only nonremedial courses among students first entering a two-year college, but it was not a significant predictor for students first entering a four-year college.

College selectivity does not predict early college success. Prior research indicates that attending a more selective college predicts higher rates of persistence, degree completion, or earnings after controlling for student background characteristics, and some researchers suggest that college selectivity may reflect peer effects (for example, students may benefit from interacting with higher achieving peers or peers with higher education–related goals; see appendix A). But among students first entering a four-year college, selectivity was not a statistically significant predictor of any individual indicator of early college success or of the composite of all three indicators.

The amount of variance that remains unexplained indicates that the state data elements are imperfect predictors of early college success. Educators and policymakers need to exercise caution in using them to identify students who may not be ready for college

Most of the variation in early college success remains unexplained

The characteristics analyzed explained 35 percent or less of the variation in students' early college success (see table C7 in appendix C). For students first entering a two-year college, the models explained 35 percent or less of the variation in the four indicators, while for students first entering a four-year college the models explained 26 percent or less of the variation. The amount of variance that remains unexplained indicates that the state data elements are imperfect predictors of early college success (as defined by these indicators). Educators and policymakers need to exercise caution in using them to identify students who may not be ready for college.

Unexplained variation in students' early college success can result if variables that may predict early college success (for example, social or emotional factors such as perseverance, high school resources, or college supports) are not included in the statistical models. It also can result if some of the included predictors are measured with error or if the way that early college success relates to the predictors differs from the way specified in the statistical models.

Implications of the study

This study has described the early college success of Indiana high school graduates, identified measures collected in Indiana state data that predict early college success, and examined the usefulness of the identified predictors. The results raise four considerations for educators and policymakers about students' early college success.

Consider targeting resources to specific subgroups of students

There were gaps in early college success between Black and White/other students (differences of 13–27 percentage points) and between students who were eligible for the school lunch program and those who were not eligible (14–22 percentage points). Although adjusting for other student- and school-level factors accounts for some of these gaps, these results suggest that educators and policymakers may want to target extra resources to those specific demographic groups.

When reporting and tracking indicators of early college successes, educators and policymakers may want to use multiple indicators because different indicators may measure different aspects of early college success

Consider using multiple indicators of early college success

The level of early college success achieved by Indiana students varies by the indicator, with the differences more pronounced for students who first entered a two-year college. When reporting and tracking indicators of early college successes, educators and policymakers may want to use multiple indicators because different indicators may measure different aspects of early college success. For example, this analysis suggests that enrolling in only nonremedial education largely reflects students' test scores (among two-year college students), perhaps because remedial placements are often based on test scores, whereas persistence relates not only to academic preparation in high school but also to student attendance in high school.

Different indicators may also relate to different goals for measuring early college success. States have multiple reasons for improving early college success, including reducing the costs of remediation and promoting upward mobility and economic growth. Although an indicator of the number of students enrolling in remedial coursework relates most closely to the first goal, the other goals relate closely to the number of students who complete a college certificate or degree, which in turn depends on persistence.[7] Using multiple indicators can support multiple goals and capture multiple dimensions of college success.

Although the Indiana Commission for Higher Education provides high schools with feedback on multiple indicators of the early college success of their graduates, recent legislation requiring the identification of students who are likely to enroll in remedial coursework addresses only one dimension of success. These policy efforts likely have different goals, but this study shows that a single indicator—enrolling in only nonremedial courses—does not necessarily reflect all dimensions of early college success or all goals that states may have in tracking it.

Consider using multiple measures to predict early college success

Measures of academic preparation in high school, both test scores and advanced coursework, are significant predictors of early college success. Student behavior (high school absences and taking the SAT or ACT) predicts some measures of early college success.

Recently created high school assessments that are aligned with the Common Core Standards (for example, those developed by the Partnership for Assessment of Readiness for College and Careers, and the Smarter Balanced Assessment Consortium) may provide better predictors of early college success than state standardized test scores do, but they still represent only one dimension of early college success and will not necessarily reflect all dimensions of academic preparation (for example, coursework) or dimensions beyond academic preparation. Early college GPA (for example, the first semester or year) may also be a promising indicator of multiple dimensions of early college success and should be considered in future research in this area.

Two-year colleges in Indiana have traditionally relied on test scores, such as those from the Accuplacer, for remedial education placement. However, students' participation in advanced coursework and their behavior predict some early postsecondary achievements, specifically earning all attempted credits, persisting to a second year, and achieving early college success by all individual indicators. These predictors may be useful for two-year colleges to consider when identifying students who are likely to achieve early college success. Although placement in remedial education represents just one dimension of early college success, future research may consider, if available, Accuplacer or ACT Compass test scores in predicting the likelihood of enrolling in only nonremedial courses. Having access to these data would very likely increase the percentage of variation that could be explained in the likelihood of enrolling in only nonremedial courses.

Although this analysis included most of the factors available in Indiana's state longitudinal data, their value in predicting early college success is limited. Additional factors not currently captured by state data could explain additional variation, but this is only speculative and would require future research

Use caution in interpreting the significance of predictors of early college success

Educators and policymakers who track predictors of early college success should use caution in interpreting the significance of the predictors. Although this analysis has identified multiple predictors of early college success, the predictors that were included (and the form in which they were included) explained only 35 percent or less of the variation in early college success. For students first entering a two-year college, less than 10 percent of the variation in earning all attempted credits and persistence to a second year was explained. Although this analysis included most of the factors available in Indiana's state longitudinal data (and shown in prior research to predict postsecondary achievements), their value in predicting early college success is limited. Additional factors not currently captured by state data (for example, social or emotional factors) could explain additional variation, but this is only speculative and would require future research.

Limitations of the study

This study has several limitations. First, the associations of student and school characteristics with the early college success measures are based on correlation analysis, so causal inferences cannot be made. Although the identified measures predict early college success, improving student performance on these measures would not necessarily lead to increases in early college success because students who perform well on the predictors may be more likely to achieve early college success anyway. However, this study identifies some measures that may help high schools distinguish students who are likely to succeed in college from students who are likely to struggle in college, to whom high schools can then provide additional resources.

Second, early college success depends on many factors such as those related to personal and financial readiness, cognitive strategies, college knowledge, academic behaviors, and

lifelong learning (Conley, 2010; Lippman, Atienza, Rivers, & Keith, 2008), but the state data do not capture all of them. Although this study has identified multiple predictors of early college success, the variation in these measures explained by the included predictors is 35 percent or less. Additional measures such as Accuplacer scores, whether students applied for federal student aid, and noncognitive factors such as goal striving and motivation could explain variation in the indicators studied and may be more important for some indicators (for example, enrolling in only nonremedial courses). Only future research can determine this.

Third, the sample excludes specific groups of students, which limits the generalizability of the findings. The sample does not include students who entered a private Indiana college or an out-of-state college. Although the vast majority of Indiana college students attend public and in-state institutions (76 percent in the current study; see figure B1 in appendix B), and state policies affect these students most directly, results cannot be generalized to students who first enter a private or out-of-state college. The sample used only one cohort of data; therefore, results cannot be generalized to cohorts from other time periods. The sample also excluded students who delay college. These students have experiences that differ from those of students who enter college directly after high school, and it may be inappropriate to analyze them together. Data on high school dropouts were unavailable and were not considered in the study (see table B1 in appendix B, for a comparison of students). The analytic sample contained almost half (47 percent) of the graduating cohort of 2010. The students in the analysis are not representative of all Indiana students, so results must be interpreted with caution.

This study has provided information on the relationships among different indicators of early college success, shown which measures in Indiana's state longitudinal data system predict success, and examined the usefulness of these measures

Despite these limitations, this study has provided information on the relationships among different indicators of early college success, shown which measures in Indiana's state longitudinal data system predict success, and examined the usefulness of these measures. The results can help Indiana policymakers—and policymakers more generally—as they consider how to identify students who are heading for college but may not be ready.

Appendix A. Literature review

College readiness is generally defined as the level of preparation needed to enter and succeed in college (ACT Inc., 2007; Conley, 2011; Wiley, Wyatt, & Camara, 2010). This level of preparation can subsequently be reflected in the early success of high school graduates entering college. Although several studies of college readiness focus on characteristics of high school students, the current study frames readiness in the context of early college success of students in college immediately after graduation from high school. There is no widely agreed-on measure of early college success; the following sections first describe measures of college readiness in the context of early college success that have been used in prior research and then describe the student- and school-level factors prior research has identified as predictors of early college success.

Measures of early college success

Students who enroll in remedial college courses, by definition, are not academically prepared for all college coursework, and students who enroll in remedial courses graduate at lower rates. In a nationally representative sample and among students who ever attended a four-year college, 49 percent of students who enrolled in any remedial courses in the first year earned a bachelor's degree within eight years of high school compared with 70 percent of students who did not enroll in any remedial courses in the first year (Adelman, 2006). Similarly, among students who first entered a two-year college, students who ever enrolled in a remedial course completed a degree (within eight years) at a rate 15 percentage points lower than that of nonremedial students (Attewell et al., 2006). The relationship between enrolling in remedial courses and degree attainment may vary, with a stronger (negative) relationship for younger students (Calcagno, Crosta, Bailey, & Jenkins, 2006), students who enroll in multiple remedial courses (Rosenbaum, Deil-Amen, & Person, 2006), or students who begin at a four-year college (Attewell et al., 2006). These (raw) differences in attainment rates suggest that enrollment in remedial courses reflects differences in students' preparation for college.

But measures of early college success based on enrollment in a remedial course can be problematic because of institutional differences in remedial education policies. Postsecondary institutions differ in the placement exams and cutoff scores used, who is required to take the placement exam, whether placement is mandatory or voluntary, and the timing of remediation (Bettinger & Long, 2009; Ewell, Boeke, & Zis, 2008; Perin, 2006). Variation in remediation policies also exists in Indiana,[8] and the state has been reducing remedial education offerings at a four-year college. Some prior research considers remediation in combination with college achievement as a measure of college readiness. For example, Conley (2011) defines college readiness as completing credit-bearing (nonremedial) general education courses with sufficient understanding to proceed to the next level. And ACT Inc. (2007) defines college readiness as having a high probability of succeeding in some first-year, credit-bearing college courses (see further discussion in the following section).

The effect of remedial education on students is a separate question (not addressed by this review) that requires comparing remedial students with similar students who did not enroll in remedial courses. There is mixed evidence on whether college remediation has a positive, neutral, or negative effect on college persistence and completion (see, for example, Adelman, 2006; Attewell et al., 2006; Bettinger & Long, 2009; and Calcagano et al., 2006, for differing results).

Completion of college credits, irrespective of whether they are credit bearing or remedial, is an alternative marker of college achievement used in some prior research (Adelman, 2006; Calcagno et al., 2006; McCormick, 1999). Earning 10 credits or earning 20 credits is seen by some as a milestone achievement associated with college completion, particularly for students of traditional age (Calcagno et al., 2006). In research on high school graduation, course failures in the first semester or in the first year of high school are associated with a lower likelihood of graduation (Allensworth & Easton, 2007). Because the rate of completing college credits reflects not only students' academic preparation but also their enrollment intensity (part-time college students accumulate credits at lower rates than full-time students do, a fact that does not necessarily indicate differences in academic preparation), a ratio of earned-to-attempted credits may better reflect academic achievement. In a study of a four-year college, Nora, Barlow, and Crisp (2005) found that students who persisted to a second year completed a higher ratio of courses attempted in their first semester of college. Using a related measure, Adelman (2006) found that withdrawing from or repeating 20 percent or more of courses during college cut the probability of earning a bachelor's degree in half. Although not a widely discussed measure of early college success, a ratio of earned-to-attempted credits may overcome problems with measures that depend on remedial course enrollment.

Early college success may ultimately be reflected in students' college persistence. The early college years may be particularly important for later attainment. In national samples of beginning postsecondary students, students left college at higher rates in their first year than in later years (Bradburn, 2002; Horn, 1998). Although some students eventually return to college, students who persist to a second year are more likely to earn a degree (or certificate) within five years or still be attending (Horn, 1998). Early persistence may be an important measure of college success because it is a first step to degree completion.

Predictors of early college success and college achievement

A range of approaches has been used to predict college success, and student, high school, and college characteristics have emerged as predictors of college achievements.

Student-level predictors of early college success. ACT Inc. and the College Board have developed benchmarks to predict readiness using college admissions exam scores. ACT's college-readiness benchmarks in English (18), reading (21), math (22), and science (24) are the scores that predict a 50 percent chance of earning a B or better (or a 75 percent chance of earning a C or better) in the corresponding first-year college courses: English composition, introductory social science, college algebra, and biology (ACT Inc., 2010). Similarly, the SAT college readiness benchmark (a composite score of 1550) is the SAT score associated with a 65 percent probability of earning a first-year college grade point average (GPA) of 2.67 or higher (a B– average at most colleges; Wyatt, Kobrin, Wiley, Camara, & Proestler, 2011).[9] Both the ACT and SAT college-readiness benchmarks are associated with college achievement. Students who achieve the ACT readiness benchmarks have a higher first-year college GPA, on average, and higher retention rates (ACT Inc., 2005). Similarly, students who achieve the SAT readiness benchmarks enter four-year colleges at higher rates and have higher retention rates (Wyatt et al., 2011).

Relying on admissions exams alone, however, is problematic for students who plan to attend college but do not take an admissions exam (two-year colleges do not require one),

and a benchmark based on a single indicator may ignore other information useful for predicting early college success. The College Board's college-readiness index uses a more comprehensive set of academic predictors—SAT scores, cumulative high school GPA, and high school academic rigor—which were selected based on the extent to which they predicted college outcomes in prior studies (Wiley et al., 2010).[10] Using a combination of test scores and GPA may yield a more accurate prediction than using either one alone (Kobrin, Patterson, Shaw, Mattern, & Barbuti, 2008).

More generally, previous research has found several student characteristics related to college achievements. White students are less likely than Black or Hispanic students to enroll in remedial courses (National Center for Education Statistics, 2012, table 243) and are more likely to attain a bachelor's degree (National Center for Education Statistics, 2012, table 345). White students are also more likely to attain a certificate or associate's degree than are Black students but are less likely to do so than Hispanic students (National Center for Education Statistics, 2012, table 345). The enrollment rate in remedial courses differs little (less than 2 percentage points) between female and male students, with male students enrolling at slightly lower rates (National Center for Education Statistics, 2012, table 243) but with female students attaining certificates, associate's degrees, and bachelor's degrees at a rate about 5 percentage points higher (National Center for Education Statistics, 2012, table 345).[11] Academic preparation and socioeconomic status are among the most consistent predictors of early college achievement. After accounting for other student characteristics, higher socioeconomic status, test scores, high school GPA, and more rigorous high school coursework are associated with a greater likelihood of college persistence or higher college GPA (Horn & Kojaku, 2001; Ishitani, 2006; Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2008; Warburton, Bugarin, & Nuñez, 2001; Wolniak & Engberg, 2010). Completing key college enrollment actions (for example, financial aid applications, college applications, and college admissions exams) predicts entering a two- or four-year college (Avery & Kane, 2004; Plank & Jordan, 2001; Roderick, Nagaoka, Coca, & Moeller, 2008) and may reflect one dimension of college readiness (Conley, 2011). Although no studies linking high school absences or suspensions (measures related to student behavior) to college outcomes were found, prior research shows that students who had a higher number of absences or who were suspended are less likely to graduate from high school (Allensworth & Easton, 2007; Balfanz, Herzog, & Mac Iver, 2007; Suh, Suh, & Houston, 2007).

In addition to some demographic characteristics (for example, race/ethnicity, gender, and socioeconomic status), prior academic achievement (that is, test scores, high school curriculum, and GPA) and completion of key enrollment actions predict college achievements. Prior research finds that behavioral measures relate to high school graduation, and they could also predict early postsecondary achievements.

Although state longitudinal data systems that track individual students through middle school, high school, and college provide a rich source of data useful for understanding the predictors of college readiness, measures not included in the data system may also matter. Conley's (2011) model of college readiness includes four dimensions: content knowledge (for example, reading, writing, and math), cognitive strategies (for example, argumentation, problem solving, and interpretation), academic behaviors (for example, self-monitoring and study skills), and college knowledge (for example, understanding the college admissions process and college norms). Lippman et al. (2008) similarly find that critical-thinking, problem-solving, and lifelong-learning skills matter to college readiness. Although Conley

(2011) suggests measures of many of these constructs, state data systems generally do not include them. Moreover, some measures suggested by Conley (2011) would be hard to collect on a widespread basis (for example, student portfolios).

High school–level predictors of early college success. Other studies have found that high school characteristics predict measures related to college success. Students who attend high schools with higher mean achievement, based on measures related to test scores or GPA, enter four-year colleges and are expected to complete a four-year degree or attain college degrees at higher rates (Bowen, Chingos, & McPherson, 2009; Engberg & Wolniak, 2010; Frost, 2007; Hill, 2008). Some research has also found that students attending high schools with a larger share of high socioeconomic status students are more likely to enter college (Hill, 2008), to enter a four-year or more selective college (Engberg & Wolniak, 2010; Klugman, 2012; McDonough, 1997; see Hill, 2008, for contradicting findings), or to attain a bachelor's degree (Frost, 2007). In national samples, students in rural areas are less likely to attain a college degree than are students in suburban or city areas (Byun, Meece, & Irvin, 2012; Provasnik et al., 2007), although this relationship may be explained by differences in socioeconomic resources (Byun et al., 2012). High school characteristics that include mean achievement, socioeconomic status, and location are associated with differences in student measures related to readiness.

College selectivity and college readiness. Prior research also finds that entering a four-year versus two-year college or a more selective college predicts higher rates of persistence or degree completion or higher earnings after accounting for many student characteristics, including measures of student academic achievement (Behrman, Rosenzweig, & Taubman, 1996; Bowen et al., 2009; Brand & Halaby, 2006; Hoekstra, 2009; Hoxby, 2001; Ishitani, 2006; Stephan et al., 2009). College selectivity may reflect peer effects (for example, students may benefit from interacting with higher achieving peers or peers with higher educational goals; Black & Smith, 2004; Bowen et al., 2009; Pascarella et al., 2006).

Although institutional selectivity relates to students' individual achievement, it is not a proxy for achievement. For example, among Chicago public high school graduates in 2005, 62 percent of students attended a college with a selectivity below that of colleges that would likely have accepted them given their academic qualifications (Roderick et al., 2008). See Bowen et al. (2009) for similar findings on mismatch based on different data.

Appendix B. Data and methodology

This appendix describes the study's data sources, data processing, and methodology.

Data sources

Regional Educational Laboratory (REL) Midwest worked directly with the Indiana Commission for Higher Education, which is represented on the College and Career Success Research Alliance, to acquire the student-level data from the Indiana Student Information System. The data consist of measures collected by the Indiana Department of Education and by the commission. The commission acquired the data from the department of education through a signed memorandum of understanding, and the data were provided to REL Midwest with the permission of the department of education. The commission collects student-level college enrollment information from public Indiana colleges and, for private and out-of-state enrollments, from the National Student Clearinghouse. High school academic characteristics are publicly available and were downloaded from the Indiana Department of Education's website (http://www.doe.in.gov/accountability/data-center). College-level data are from two sources, publicly available Integrated Postsecondary Education Data System data accessed through its website (http://nces.ed.gov/ipeds/datacenter/) and selectivity rankings from *Barron's Profiles of American Colleges* (Barron's Educational Series, 2010).

Data processing and creation of the analytic samples

Data provided to REL Midwest consisted of all 2010 Indiana high school students (68,802), identified by an anonymous identification number (figure B1). The 2010 cohort of Indiana high school graduates was chosen for analysis for two reasons: it was the most recent cohort for which persistence data were available, and it was the first cohort for which National Student Clearinghouse data were available.

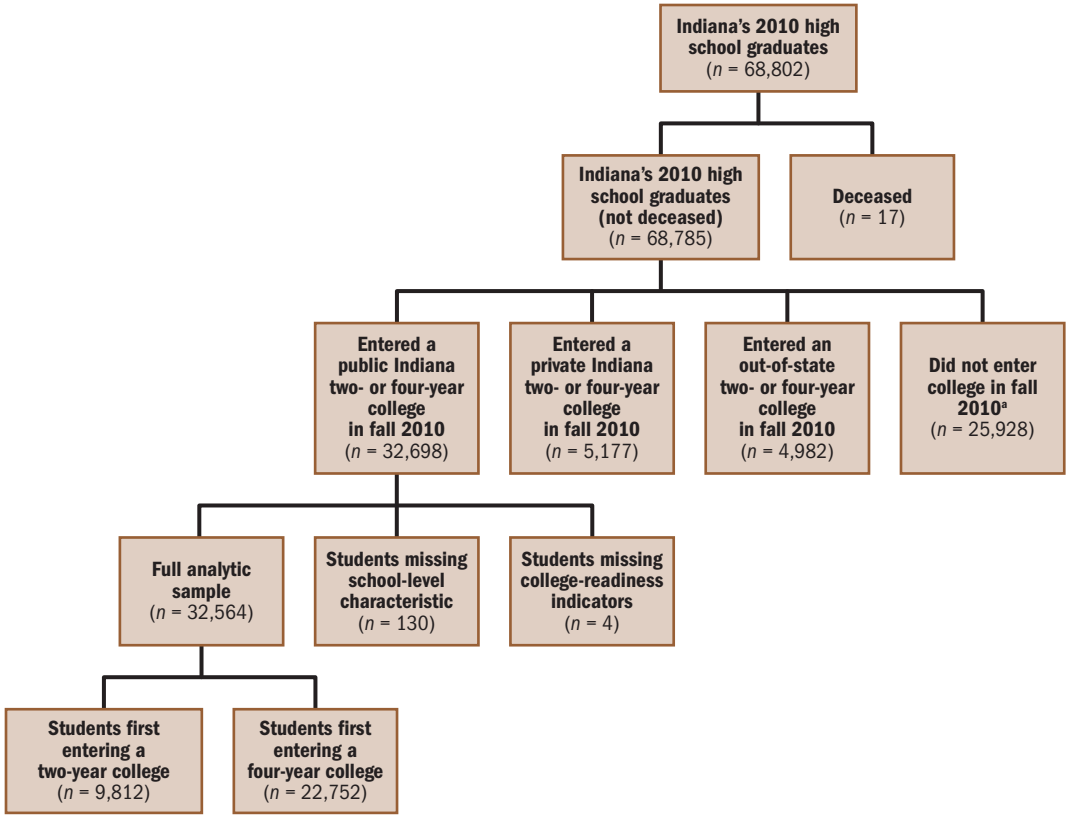
Creation of the three analytic datasets—the full sample, students first entering a two-year college, and students first entering a four-year college—required removing students identified as deceased between fall 2010 and fall 2011 (17 students); students who did not enter a public Indiana college in fall 2010 (36,087); students missing data for enrolling in remedial courses, earning all attempted credits, or persisting to a second year (4); and students missing data on the school-level characteristic (the percentage of students passing the grade 10 English end-of-course exam; (130). The final sample has 32,564 students (full sample), with 9,812 students first entering a two-year college and 22,752 students first entering a four-year college.

Variable creation

This section describes the variables created from the raw data. Variables that did not require significant manipulation (for example, gender) are not described.

Race/ethnicity. In the Indiana data, race/ethnicity is categorized into one of six categories: Black, Hispanic, White, Asian, Native American/Alaskan Native, and Two or More Races. These categories were reduced to three for the analysis: Black, Hispanic, and White/other. Although Black and Hispanic students are both historically underrepresented in higher

Figure B1. Creation of the analytic samples



a. Twenty-seven students who entered a less than two-year postsecondary institution (for example, a cosmetology school) were classified as not entering college because these institutions do not grant degrees. Students who entered a private or out-of-state college that does not participate in the National Student Clearinghouse were classified as not entering college because any such college enrollments cannot be identified in the data.

Source: Authors.

education, these groups differ from each other in their education expectations and college entrance patterns: in nationally representative samples, Black students have higher postsecondary education expectations and enter four-year colleges at higher rates than Hispanic students do (Berkner & Chavez, 1997; Bozick & Lauff, 2007; Ingels et al., 2005). Because of documented differences in the postsecondary education pathways of Black and Hispanic students, the analyses consider these two groups separately. The category White/other includes White students (95 percent of students), Asian students (2 percent), Native American/Alaskan Native students (0.2 percent), and students of two or more races (3 percent). In the analytic sample, Asian students entered college at the highest rates (74 percent) followed by White students (64 percent). Although the college entrance rates of Native Americans/Alaskan Native students and students of two or more races (45 and 58 percent respectively) are lower than that of other students in this category, the small number of students in these groups precludes the creation of separate categories for them in the regression analysis.

College enrollment data. The analytic samples consisted of Indiana's 2010 high school graduates who entered a public Indiana two- or four-year college in fall 2010 based on data collected by the Indiana Commission for Higher Education. Students who did not enter a public Indiana two- or four-year college in fall 2010 could have entered a private

Indiana two- or four-year college, an out-of-state college, or a less than two-year college (for example, a cosmetology school) or could have not entered any postsecondary institution (see figure B1).

For commission data, a student was considered enrolled in fall 2010 if that student was enrolled on the institution's census enrollment date. For students in a private Indiana or out-of-state college (according to the National Student Clearinghouse), those enrolled on October 4, 2010, were considered enrolled in fall 2010, and students who were enrolled on October 3, 2011, were considered enrolled in fall 2011. Colleges' actual census enrollment dates and terms may differ. These dates were chosen after reviewing the census enrollment dates for colleges frequently attended by Indiana high school graduates (in-state and out-of-state colleges).

In the commission data, there were 86 students in more than one college in fall 2010. The "primary" institution was identified by taking the institution associated with a full-time enrollment before an institution associated with a part-time enrollment. For students with the same status at multiple institutions, the institution associated with the largest number of enrolled credits was selected as the primary institution. The National Student Clearinghouse data were used to identify whether a student was enrolled in fall 2011. It was not necessary to identify which institution was the primary institution to construct the persistence measure.

For some enrollments, the commission and clearinghouse data were contradictory. That is, some students identified by the commission as enrolled in an Indiana public college were not identified by the clearinghouse as enrolled in an Indiana public college and vice versa. In all cases, commission data were considered more accurate than clearinghouse data, because the matching algorithm in the Indiana state longitudinal data system uses information additional to that used for the matching that occurs between Indiana data and clearinghouse data.

If students who first entered a public Indiana college in fall 2010 later transferred to a private or out-of-state institution, the persistence indicator captured that transfer. However, because there is no national source that captures postsecondary coursework at the student level (for example, remedial courses or earning all attempted credits), the sample had to be limited to students entering a public Indiana college.

College-readiness indicators. The analysis used three indicators of college readiness and a composite of all three indicators:

- *Enrolled in only nonremedial courses.* This indicator equals 1 if a student was enrolled in a remedial course (math or English) at the end of the first semester of college (fall 2010) and 0 otherwise. Students who qualified for a remedial course but did not enroll in one could not be distinguished from students who did not qualify for a remedial course. The vast majority of students (90 percent) who enroll in a remedial course in the first year do so in their first semester of college. Whether a student enrolled in a remedial course is available only for students in public Indiana colleges.
- *Earning all attempted credits.* This indicator equals 1 if a student earned all attempted credits (remedial or not) in the first semester of college (fall 2010) and 0 otherwise. Students who did not earn all attempted credits include students who failed

a course (earned less than a D– or failed a pass/fail course), those who withdrew late, and those who received an incomplete. Data on enrolling in and earning credits are available only for students in public Indiana colleges.

- *Persisted to a second year.* This indicator equals 1 if a student who entered a public Indiana college in fall 2010 attended any college (public, private, in state, or out of state) in fall 2011. Otherwise, it equals 0. Less than 2 percent of students dropped out in spring 2011 and returned in fall 2011. This indicator is consistent with commission's reporting of persistence. Information from the National Student Clearinghouse was used to identify students who transferred to a private or out-of-state college (n = 492).
- *Early college success by all individual indicators*. This composite equals 1 if a student is identified as demonstrating early college success by each of the three indicators: enrolling in only nonremedial courses in the first semester, earning all attempted credits in the first semester, and persisting to a second year. It equals 0 otherwise.

Type of college entered first. The type of college (two or four year) a student first entered in fall 2010 was identified using the Integrated Postsecondary Education Data System data. Although classified by this system as a four-year college, Vincennes University has an open-admissions policy and grants primarily associate's degrees.[12] To reflect the university's mission and to remain consistent with commission reporting, the analysis classifies Vincennes University as a two-year college.

College selectivity. Four-year colleges were classified into three categories based on the Barron's selectivity ranking. Barron's classifies colleges into categories based on the academic qualifications of students at the college (SAT or ACT scores, class rank, and high school GPA) and the percentage of applicants accepted (Barron's Educational Series, 2010). The Barron's index has been used in many studies of college outcomes (for example, Dale & Krueger, 2011; Hoxby, 2001; Roderick et al., 2008), and the National Center for Education Statistics makes it available (to users with a restricted data license) for merging with many of its longitudinal datasets (for example, the National Longitudinal Study of the High School Class of 1972, the High School and Beyond longitudinal study, the National Educational Longitudinal Study of 1988, the Educational Longitudinal Study of 2000, and the Beginning Postsecondary Students Study). The Barron's ranking classifies the selectivity of four-year colleges based on the academic qualifications of students at the college and the percentage of applicants accepted (Barron's Educational Series, 2010). For the analysis, the Barron's categories were collapsed to three: less competitive (corresponding to Barron's categories of less competitive and noncompetitive), competitive (corresponding to the Barron's competitive category), and more competitive (corresponding to the Barron's categories of very, highly, and most competitive). One four-year college, Purdue University–North Central Campus, was not ranked by Barron's (2010). Based on the similarity of this college's admission rates and SAT/ACT scores with four-year public colleges in Indiana rated by Barron's as less competitive, Purdue University–North Central Campus was considered to have a selectivity ranking of less competitive. Indiana public four-year colleges are listed by selectivity in box B1.

Diploma type. Indiana offers four types of high school diplomas: general, Core 40, Core 40 with academic honors, and Core 40 with technical honors (see box 3 in the main report). The vast majority of students who earned a Core 40 diploma with honors earned one with academic honors, and therefore the category "earned Core 40 diploma with honors" was

Box B1. Selectivity of Indiana's 14 public four-year colleges, 2010

Indiana's four-year colleges were classified into three categories based on the Barron's selectivity rankings.

Less competitive
Indiana University–East
Indiana University–Kokomo
Indiana University–Northwest
Indiana University–Purdue University–Fort Wayne
Indiana University–South Bend
Indiana University–Southeast
Purdue University–Calumet Campus
Purdue University–North Central Campus
University of Southern Indiana

Competitive
Ball State University
Indiana State University
Indiana University–Purdue University–Indianapolis

More competitive
Indiana University–Bloomington
Purdue University–Main Campus

Source: Authors' classification based on Barron's selectivity rankings (Barron's Educational Series, 2010).

created. This category includes students who earned a Core 40 diploma with academic honors (n = 12,098), students who earned the Core 40 diploma with technical honors (n = 275), students who earned the Core 40 diploma with both technical and academic honors (n = 198), and students who earned an International Baccalaureate diploma (n = 60).

Indiana Statewide Testing for Educational Progress—Plus (ISTEP+) scores. For the cohort in this study, ISTEP+ math and English language arts assessments were administered to capture learning in grades 3–8 and grade 10. Math and English language arts scores and ratings (passed versus not passed) were provided by the commission for grades 7–10. For students in the study cohort, the ISTEP+ assessments were administered in the fall of each school year. The grade 7 ISTEP+ score, for example, refers to the exam given in the fall of grade 7, which would capture learning primarily in grade 6. The grade 10 ISTEP+ math and English language arts assessments make up the Graduate Qualifying Exam, which students must pass to receive a diploma. Beginning in 2009/10, ISTEP+ has been administered to grades 3–8 and end-of-course exams have been administered for Algebra I and English 10. For each grade, composite scores were calculated by separately standardizing the math and English language arts scores, summing the result, and then standardizing the sum. Standardization was based on the scores of all 2010 high school graduates. Because of the high correlation among scores, the regressions include only grade 10 composite scores, which were the most recent scores and those with the least amount of missing data. Table C6 in appendix C shows college-readiness rates for subgroups defined by score ratings in earlier grades.

High school absences. Students' high school absences were calculated as the sum of unexcused and excused absences between 2006/07 and 2009/10, which corresponds to four years of high school for students who remained on track. Three categorical variables were created based on the 33rd and 66th percentile cutpoints from the distribution of high school absences among all 2010 Indiana high school graduates. These cutpoints correspond to fewer than 15 absences and 31 or more absences.

Taking the SAT or ACT. The College Board and ACT provide SAT and ACT scores to the Indiana Department of Education. This analysis assumes that if a student does not have an SAT or ACT score, the student did not take the SAT or ACT. A missing SAT or ACT score could alternatively be explained if there was a problem matching SAT and ACT records to state data.

School percentage of grade 10 students passing the English end-of-course exam in 2010. This measure reflects the achievement level of a student's high school peers in the year the student graduated. Because the state-administered tests changed between the time the students in the study cohort were sophomores and the time they became seniors, this school-level measure is based on a different test (the grade 10 English end-of-course exam) than the test score included at the student level (the ISTEP+ English language arts score is one component of the composite score included in the regressions). The study team considered including the percentage of students eligible for the school lunch program as a high school characteristic variable in the regression models. However, the variable was highly correlated with the percentage of grade 10 students passing the English end-of-course exam in 2010 (correlation coefficient = −0.72) and had slightly more missing data (136 students). Researchers did not consider including the percentage of students passing the Algebra I end-of-course exam. This measure does not necessarily reflect the achievement level of a high school because students in advanced math classes can take this assessment in grade 7 or grade 8.

Table B1 shows the sample proportions (unless the label indicates the mean) at the student level for variables included in the dataset for all 2010 Indiana public high school graduates, for the overall analytic sample, and for students in the sample who first entered a two- or four-year college.

Table B1. Means of variables included in analysis for analytic sample

Characteristic	All 2010 Indiana high school graduates[a] (*n* = 68,785)		Full sample (*n* = 32,564)		Entering a two year college sample (*n* = 9,812)		Entering a four year college sample (*n* = 22,752)	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Student characteristics								
Gender								
Female	34,915	50.8	17,603	54.1	5,054	51.5	12,549	55.2
Male	33,870	49.2	14,961	45.9	4,758	48.5	10,203	44.8
Race/ethnicity								
Asian, non-Hispanic	1,050	1.5	599	1.8	88	0.9	511	2.2
Black, non-Hispanic	6,779	9.9	2,895	8.9	1,182	12.0	1,713	7.5
White, non-Hispanic	55,765	81.1	27,035	83.0	7,867	80.2	19,168	84.2
Hispanic (any race)	3,332	4.8	1,246	3.8	428	4.4	818	3.6
Other/multiple races, non-Hispanic	1,672	2.4	730	2.2	221	2.3	509	2.2
Eligibility for school lunch program								
Eligible	18,719	27.3	7,221	22.2	3,035	31.0	4,186	18.4
Not eligible	49,885	72.5	25,311	77.7	6,758	68.9	18,553	81.5
Unknown eligibility	181	0.3	32	0.1	19	0.2	13	0.1
Diploma type earned								
General diploma	15,854	23.0	3,364	10.3	2,802	28.6	562	2.5
Core 40 diploma	32,561	47.3	16,662	51.2	6,216	63.4	10,446	45.9
Core 40 diploma with honors	20,370	29.6	12,538	38.5	794	8.1	11,744	51.6
Available of Indiana Statewide Testing for Educational Progress—Plus composite scores								
Grade 7	59,554	86.6	29,523	90.7	8,758	89.3	20,765	91.3
Grade 8	62,484	90.8	30,460	93.5	9,102	92.8	21,358	93.9
Grade 9	64,058	93.1	31,085	95.5	9,217	93.9	21,868	96.1
Grade 10	65,209	94.8	31,451	96.6	9,332	95.1	22,119	97.2
ACT composite score								
9–20	5,829	8.5	3,373	10.4	1,011	10.3	2,362	10.4
21–24	4,313	6.3	2,582	7.9	262	2.7	2,320	10.2
25–36	4,618	6.7	2,634	8.1	61	0.6	2,573	11.3
SAT composite score								
600–1350	12,141	17.7	7,243	22.2	2,795	28.5	4,448	19.5
1360–1580	11,765	17.1	7,635	23.4	1,243	12.7	6,392	28.1
1590–2400	11,353	16.5	7,037	21.6	382	3.9	6,655	29.3
Dual credit								
Earned at least one dual credit	5,785	8.4	5,322	16.3	1,262	12.9	4,060	17.8
Did not earn dual credits	63,000	91.6	27,242	83.7	8,550	87.1	18,692	82.2
Advanced Placement exam								
Took at least one exam	18,468	26.8	11,241	34.5	839	8.6	10,402	45.7
Did not take any exams	50,317	73.2	21,323	65.5	8,973	91.4	12,350	54.3
Passed Advanced Placement exam								
Took and passed at least one exam	7,893	11.5	4,661	14.3	143	1.5	4,518	19.9
Took at least one exam but did not pass any	10,575	15.4	6,580	20.2	696	7.1	5,884	25.9
Took college entrance exam (ACT or SAT)								
Took either ACT or SAT	39,193	57.0	24,041	73.8	5,124	52.2	18,917	83.1
Did not take the ACT or SAT	29,592	43.0	8,523	26.2	4,688	47.8	3,835	16.9

(continued)

Table B1. Means of variables included in analysis for analytic sample *(continued)*

Characteristic	All 2010 Indiana high school graduates[a] (*n* = 68,785)		Full sample (*n* = 32,564)		Entering a two year college sample (*n* = 9,812)		Entering a four year college sample (*n* = 22,752)	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Cumulative grade point average								
0.0–2.9	10,092	14.7	9,311	28.6	3,169	32.3	6,142	27.0
3.0–3.5	9,861	14.3	9,404	28.9	895	9.1	8,509	37.4
3.6–4.0	8,215	11.9	7,914	24.3	280	2.9	7,634	33.6
High school absences, 2006/07–2009/10								
Less than 15 days	22,127	33.8	12,287	38.9	2,779	29.4	9,508	43.0
15–30 days	21,593	33.0	10,592	33.6	3,109	32.9	7,483	33.9
31 or more days	21,807	33.3	8,681	27.5	3,572	37.8	5,109	23.1
High school characteristics								
Percentage of students in high school attended who passed English end-of-course exam								
Less than 59 percent	23,439	34.1	9,739	29.9	3,561	36.3	6,178	27.2
59–70 percent	22,577	32.8	10,504	32.3	3,501	35.7	7,003	30.8
More than 70 percent	22,413	32.6	11,651	35.8	2,512	25.6	9,139	40.2
College enrollment, fall 2010								
Two-year Indiana public college (all types)	9,812	14.3	9,812	30.1	9,812	100.0	na	na
Vincennes University	1,789	2.6	1,789	5.5	1,789	18.2	na	na
Four-year Indiana public college								
Less competitive college	7,347	10.7	7,347	22.6	na	na	7,347	32.3
Competitive college	7,522	10.9	7,522	23.1	na	na	7,522	33.1
More competitive college	7,883	11.5	7,883	24.2	na	na	7,883	34.6

a. All 2010 Indiana public high school graduates were included except for 17 students who the National Student Clearinghouse indicated were deceased during the study period.

na is not applicable.

Source: Authors' calculations based on data from the Indiana state longitudinal system.

Missing data. Overall, rates of missing data were low (table B2). For students missing school lunch program eligibility status in 2009/10 (120 students), values from 2008/09 or 2007/08 were used when available (for 87 students). Missing data could not be distinguished from nonparticipation for the ACT, SAT, Advanced Placement (AP) exams, and dual credits. If students did not have an ACT or SAT score, it was assumed that they did not take the ACT or SAT. If students did not have an AP score, it was assumed that they did not take an AP exam. And if students did not have a record of dual credits earned, it was assumed that they did not earn any. For hierarchical linear models, which require complete cases, missing values for grade 10 ISTEP+ composite scores were replaced with the sample mean and a missing data indicator was created. Missing data flags also were created for school lunch program eligibility and high school absences, two categorical variables.

Data analysis

Research question 1. To answer research question 1, the percentage of students achieving each indicator of college readiness was calculated overall and by student subgroup. Chi-square tests indicate statistically significant differences in college readiness for all subgroups (defined, for example, by gender, race/ethnicity, diploma type) examined in table C6 in appendix C (and discussed in the text). In all cases, the *p*-values, which were

Table B2. Rates of missing data in the analytic sample for the variables included in the analysis

Variable	Number of students with valid data	Percentage of students with missing data
Student indicators of early college success		
Enrolled in only nonremedial courses in the first semester of college	32,564	0.0
Completed all attempted courses in the first semester of college	32,564	0.0
Attending any college one year after initial enrollment	32,564	0.0
Student demographic characteristics		
Gender	32,564	0.0
Race/ethnicity	32,564	0.0
School lunch program eligibility status	32,532	0.1
Student academic characteristics		
Grade 10 ISTEP+ standardized composite score	31,451	3.4
Indicator of taking ACT or SAT	32,564	0.0
Earned at least one dual credit	32,564	0.0
Number of Advanced Placement exams taken	32,564	0.0
Number of Advanced Placement exams passed	32,564	0.0
High school diploma type	32,564	0.0
Student attendance		
Number of days student was absent over 2006/07–2009/10	31,560	3.1
High school characteristic		
School percentage of grade 10 students who passed English end-of-course exam in 2010	32,564	0.0
College characteristic		
Indicator of Vincennes University	32,564	0.0
Barron's rating for primary institution in fall 2010	22,365	31.3

ISTEP+ is Indiana Statewide Testing for Educational Progress—Plus.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

corrected using a Bonferroni adjustment for multiple testing,[13] were less than .001. This level of statistical significance reflects the large sample size, and not all results are necessarily substantively significant.

Research question 2. For research question 2, eight two-level cross-classified random effects logistic regression models were estimated, four for students first entering a two-year college and four for students first entering a four-year college, corresponding with the four binary outcomes. The models were estimated using hierarchical linear models software.

To model each of the college-readiness indicators, the probability of achieving the indicator $u_{ijk} = P(Y_{ijk} = 1)$, for student i in high school j and college k, is transformed using the logit link, which is the log of the odds, where the odds is the probability of the event (for example, attending college one year after first enrollment) divided by 1 minus the probability of the event:

$$\eta_{ijk} = \log\left(\frac{u_{ijk}}{1-u_{ijk}}\right).$$

The above transformed variable is then modeled as the outcome in the following two-level cross-classified model:

Level 1 model (the within-cell model):

$$\eta_{ijk} = \pi_{0jk} + \sum_{p=1}^{P} \pi_{pjk} a_{pijk} + e_{ijk}$$

where
$i = 1, \ldots, n_{jk}$ students in cell jk,
$j = 1, \ldots, J$ high schools,
$k = 1, \ldots, K$ colleges,
a_{pijk} is the p^{th} student characteristic for student i in high school j and college k, $p = 1, \ldots, P$, and
e_{ijk} is a random error term for student i in high school j and college k.

Level 2 model (the between-cell model):

$$\pi_{0jk} = \theta_0 + \sum_{r=1}^{R} \gamma_{0r} W_{0rj} + \sum_{q=1}^{Q} \beta_{0q} X_{0qk} + b_{00j} + c_{00k}$$

$$\pi_{0jk} = \theta p \quad \text{for } p > 0$$

where
W_{0rj} is the r^{th} characteristic for high school j, $r = 1, \ldots, R$,
X_{0qk} is the q^{th} characteristic for college k, $q = 1, \ldots, Q$,
b_{00j} is the random main effect of high school j, and
c_{00k} is the random main effect of college k.

Because of the potential complexity of cross-classified models and the small within-cell sample sizes,[14] the models constrained the effects of high school characteristics to be fixed across colleges and the effects of college characteristics to be fixed across high schools, constrained all student characteristics to be fixed, and omitted a random effect associated with a high school-by-college interaction. The random interaction effect is frequently omitted from cross-classified random effects models (Beretvas, 2008) because the small within-cell sample size makes it difficult to reliably distinguish from within-cell error (Beretvas, 2008; Raudenbush & Bryk, 2002). The models included the student, high school, and college characteristics listed in tables C1 and C2 in appendix C, which present the regression coefficients, standard errors, and statistical significance. In all cases, a more conservative approach was taken to account for multiple testing across outcomes. The *p*-values were corrected using a Bonferroni adjustment for multiple testing (that is, the adjusted *p*-value was the minimum of 1 or the raw *p*-value multiplied by 4, corresponding to the four dependent variables).

Predicted probability. The main report describes output from the regression models in terms of predicted probabilities rather than log-odds or odds ratios (see tables C1 and C2 in appendix C, for regression coefficients). For example, to calculate the change in predicted probability in earning all attempted credits associated with earning at least one dual credit, the following steps were taken. First, the linear predictor of the log odds of earning

all attempted credits was calculated for students who took a dual-credit class. This linear predictor was calculated as the sum of the estimated coefficient of earning a dual credit multiplied by 1 minus the grand mean of earning a dual credit, and the intercept. Second, the predicted probability of earning all attempted credits for students who earned a dual credit was calculated as a transformation of the linear predictor: this probability equals {1/[1+exp(−1**linear_predictor*)]}. Third, the corresponding linear predictor and probability of earning all attempted credits was calculated for students who earned no dual credits. Finally, the difference between the two predicted probabilities was calculated. This value indicates the difference in predicted probabilities associated with earning a dual credit for a "typical" student, where typical refers to a student whose values for all variables except earning a dual credit are at the grand mean values among students in the model, and the random student, high school, and college effects equal 0.

Percent variance explained. Unlike a hierarchical linear model with a continuous dependent variable, hierarchical linear models with a binary dependent variable do not provide estimates of the interclass correlation to use in parsing variance between student and school levels. Snijders and Bosker (1999) have developed an approach to estimating variance explained that can be used for two-level models with a binary dependent variable. Extending Snijders and Bosker's approach to cross-classified models, the percent variance explained is calculated as:

$$R^2_{dicho} = \frac{\sigma^2_F}{\sigma^2_F+\tau^2_{b00}+\tau^2_{c00}+\sigma^2_R},$$

where σ^2_F is the variance of the linear predictor for outcome *Y*, τ^2_{b00} is the variance between high schools, τ^2_{c00} is the variance between colleges, and σ^2_R is the Level 1 residual variance, fixed at $\frac{\pi^2}{3}$ for the logistic regression.

The R^2 value for a single-level logistic regression (pseudo R^2) is generally lower than the ordinary least squares R^2 values for predicting continuous outcomes (Snijders & Bosker, 1999); therefore, this estimate of the percent variance explained should be considered conservative.

Appendix C. Additional results

The following tables and figures present additional and more detailed results from the analyses in the main text.

Table C1. Coefficients, standard errors, and statistical significance for models predicting early college success among students first entering a two-year college, 2010 college freshmen

Characteristic	Enrolling in only nonremedial courses Coefficient (standard error)	Earning all attempted credits Coefficient (standard error)	Persisting to second year Coefficient (standard error)	Early college success by all indicators Coefficient (standard error)
Student characteristic				
Intercept	−1.06***	−0.07	0.19***	−2.46***
	(0.04)	(0.07)	(0.04)	(0.08)
Female	−0.51***	0.36***	0.24***	−0.17*
	(0.05)	(0.04)	(0.04)	(0.07)
Black	−0.24	−0.58***	−0.30***	−0.75***
	(0.10)	(0.08)	(0.08)	(0.19)
Hispanic	−0.30	0.22	0.17	−0.07
	(0.14)	(0.11)	(0.11)	(0.19)
Eligible for school lunch program	−0.09	−0.14*	−0.21***	−0.24*
	(0.06)	(0.05)	(0.05)	(0.09)
Grade 10 ISTEP+ composite score	1.43***	0.10**	0.09**	1.05***
	(0.05)	(0.03)	(0.03)	(0.06)
Earned at least one dual credit	0.29***	0.24***	0.28***	0.50***
	(0.07)	(0.06)	(0.07)	(0.08)
Took at least one Advanced Placement exam	0.67***	0.32***	0.28**	0.67***
	(0.09)	(0.08)	(0.08)	(0.09)
Took ACT or SAT	0.35***	0.17***	0.44***	0.43***
	(0.05)	(0.04)	(0.04)	(0.07)
Absent 15–30 days between 2006/07 and 2009/10	0.04	−0.39***	−0.30***	−0.27**
	(0.06)	(0.05)	(0.06)	(0.08)
Absent 31 or more days between 2006/07 and 2009/10	0.08	−0.72***	−0.64***	−0.53***
	(0.06)	(0.05)	(0.06)	(0.08)
Missing indicator for school lunch program eligibility	0.62	0.37	0.54	0.95
	(0.49)	(0.49)	(0.49)	(0.67)
Missing indicator for grade 10 ISTEP+ composite score	−0.66***	−0.10	−0.16	−0.34
	(0.13)	(0.12)	(0.12)	(0.19)
Missing indicator for absences	0.13	−0.49**	−0.40*	−0.37
	(0.16)	(0.14)	(0.14)	(0.23)
High school characteristic				
Percentage of students who passed the English end-of-course exam in 2010	1.30***	0.90***	1.05***	2.05***
	(0.25)	(0.19)	(0.20)	(0.32)
College characteristic				
First entered Vincennes University	0.55**	0.04	0.55**	0.53
	(0.12)	(0.26)	(0.13)	(0.26)

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*** Bonferroni-adjusted p-value < .001; ** Bonferroni-adjusted p-value < .01; * Bonferroni-adjusted p-value < .05.

Note: Bonferroni adjustments take into account that the analysis examines four related dependent variables.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Table C2. Coefficients, standard errors, and statistical significance for models predicting early college success among students first entering a four-year college, 2010 college freshmen

Characteristic	Enrolling in only nonremedial courses	Earning all attempted credits	Persisting to second year	Early college success by all indicators
	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)
Student characteristic				
Intercept	3.58***	1.39***	1.78***	0.70***
	(0.58)	(0.08)	(0.06)	(0.08)
Female	−0.18*	0.50***	0.40***	0.35***
	(0.05)	(0.04)	(0.04)	(0.03)
Black	−0.08	−0.43***	0.00	−0.32***
	(0.09)	(0.07)	(0.08)	(0.07)
Hispanic	−0.11	0.02	0.01	−0.10
	(0.12)	(0.09)	(0.11)	(0.09)
Eligible for school lunch program	−0.07	−0.24***	−0.26***	−0.28***
	(0.06)	(0.04)	(0.05)	(0.04)
Grade 10 ISTEP+ composite score	1.24***	0.41***	0.17***	0.67***
	(0.05)	(0.03)	(0.04)	(0.03)
Earned at least one dual credit	0.31**	0.36***	0.32***	0.35***
	(0.07)	(0.05)	(0.06)	(0.05)
Took at least one Advanced Placement exam but did not pass any	0.43***	0.47***	0.42***	0.50***
	(0.07)	(0.05)	(0.05)	(0.04)
Took and passed at least one Advanced Placement exam	0.73***	0.76***	0.78***	0.78***
	(0.11)	(0.07)	(0.08)	(0.06)
Took ACT or SAT	0.08	0.04	0.13	0.09
	(0.07)	(0.05)	(0.06)	(0.05)
Absent 15–30 days between 2006/07 and 2009/10	−0.08	−0.39***	−0.38***	−0.39***
	(0.06)	(0.04)	(0.05)	(0.04)
Absent 31 or more days between 2006/07 and 2009/10	−0.07	−0.77***	−0.76***	−0.73***
	(0.06)	(0.05)	(0.05)	(0.04)
Missing indicator for school lunch program eligibility	−0.58	−1.51	−0.70	−1.41
	(0.74)	(0.61)	(0.60)	(0.69)
Missing indicator for grade 10 ISTEP+ composite score	−0.38	−0.01	−0.21	−0.06
	(0.16)	(0.11)	(0.13)	(0.11)
Missing indicator for absences	0.26	−0.56***	−0.55**	−0.52***
	(0.18)	(0.12)	(0.14)	(0.11)
High school characteristic				
Percentage of students who passed the English end-of-course exam in 2010	−0.04	1.30***	1.35***	1.11***
	(0.25)	(0.19)	(0.21)	(0.18)
College characteristic				
Less competitive four-year college	−1.26	−0.22	−0.41	−0.28
	(1.46)	(0.19)	(0.14)	(0.20)
More competitive four-year college	0.54	0.26	0.83	0.36
	(2.01)	(0.26)	(0.19)	(0.27)

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*** Bonferroni-adjusted *p*-value < .001; ** Bonferroni-adjusted *p*-value < .01; * Bonferroni-adjusted *p*-value < .05.

Note: Bonferroni adjustments take into account that the analysis examines four related dependent variables.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Table C3. Percentage of students who enrolled in only nonremedial courses and the percentage who earned all attempted credits, 2010 college freshmen

		Earned all attempted credits		
		Yes	No	Total
Enrolled in only nonremedial courses	Yes	55	17	72
	No	14	14	28
	Total	69	31	100

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Table C4. Percentage of students who enrolled in only nonremedial courses and the percentage who persisted to a second year, 2010 college freshmen

		Persisted to second year		
		Yes	No	Total
Enrolled in only nonremedial courses	Yes	60	12	72
	No	17	11	28
	Total	77	23	100

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Table C5. Percentage of students who earned all attempted credits and the percentage who persisted to a second year, 2010 college freshmen

		Persisted to second year		
		Yes	No	Total
Earned all attempted credits	Yes	62	8	69
	No	16	15	31
	Total	77	23	100

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Table C6. Percentage of students demonstrating early college success by student subgroup, 2010 college freshmen

Student characteristic	Number of students	Enrolled in only nonremedial courses	Earned all attempted credits	Persisted to a second year	Early college success by all indicators
Gender					
Female	17,603	70.2	72.1	78.7	51.4
Male	14,961	74.2	65.6	75.3	48.9
Race/ethnicity					
Black	2,895	51.8	47.8	65.3	26.3
Hispanic	1,246	62.4	66.5	73.7	39.7
White/other	28,423	74.5	71.3	78.5	53.2
Eligibility for school lunch program					
Eligible	7,221	58.4	56.4	66.1	32.8
Not eligible	25,311	76.0	72.7	80.3	55.3
Grade 7 ISTEP+ rating, math					
Passed	26,560	77.2	71.9	79.6	54.9
Did not pass	3,019	29.8	48.1	59.5	14.8
Grade 8 ISTEP+ rating, math					
Passed	26,973	77.8	72.0	79.8	55.5
Did not pass	3,546	29.8	48.5	59.5	14.2
Grade 9 ISTEP+ rating, math					
Passed	26,972	78.9	72.6	80.3	56.5
Did not pass	4,236	30.7	49.1	59.0	14.2
Grade 10 ISTEP+ rating, math					
Passed	27,002	79.6	73.0	80.6	57.1
Did not pass	4,553	29.4	48.0	59.1	13.1
Grade 7 ISTEP+ rating, English language arts					
Passed	25,823	77.9	72.3	80.2	55.8
Did not pass	3,905	36.7	50.8	60.9	19.1
Grade 8 ISTEP+ Rating, English language arts					
Passed	26,376	78.4	72.1	79.9	55.9
Did not pass	4,111	33.0	51.6	61.2	17.3
Grade 9 ISTEP+ Rating, English language arts					
Passed	27,443	78.1	72.4	80.1	55.8
Did not pass	3,737	29.8	47.7	57.6	13.9
Grade 10 ISTEP+ rating, English language arts					
Passed	27,523	78.6	72.5	80.3	56.1
Did not pass	4,052	29.8	48.5	57.9	14.0
SAT score					
600–1350	7,243	54.5	61.1	72.2	31.4
1360–1580	7,635	87.5	73.7	83.3	60.9
1590–2400	7,037	97.5	86.7	91.8	81.5
ACT score					
9–20	3,373	63.2	63.7	75.7	39.3
21–24	2,582	92.9	81.8	88.7	72.3
25–36	2,634	98.4	91.5	94.8	87.8

(continued)

Table C6. Percentage of students demonstrating early college success by student subgroup, 2010 college freshmen *(continued)*

Student characteristic	Number of students	Enrolled in only nonremedial courses	Earned all attempted credits	Persisted to a second year	Early college success by all indicators
Dual credits earned					
Earned at least one dual credit	5,322	81.7	77.9	84.2	62.6
Did not earn any dual credits	27,242	70.2	67.4	75.7	47.9
Advanced Placement exam achievement					
Took and passed at least one exam	4,661	96.7	90.7	94.3	85.6
Took at least one exam but did not pass any	6,580	89.3	80.9	87.8	69.1
Did not take any exams	21,323	61.3	60.7	70.1	36.7
High school grade point average					
0.0–2.9	9,311	62.1	52.5	67.9	29.3
3.0–3.5	9,404	86.1	78.5	86.5	63.2
3.6–4.0	7,914	95.5	93.7	95.3	87.0
High school diploma type					
General	3,364	26.7	35.6	46.3	7.6
Core 40	16,662	64.5	60.7	71.3	35.7
Core 40 with honors	12,538	94.2	89.2	93.0	81.1
High school absences					
Fewer than 15 days	12,287	77.8	78.3	85.0	61.6
15–30 days	10,592	72.2	68.9	77.6	49.5
31 or more days	8,681	64.1	57.0	66.0	36.0
ACT or SAT test taking					
Took ACT or SAT	24,041	78.7	72.7	81.4	56.2
Did not take ACT or SAT	8,523	53.4	58.7	65.0	33.4

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Note: For every subgroup (defined, for example, by gender, race/ethnicity, diploma type), there were statistically significant differences ($p < .001$) in college readiness (for each individual indicator and the composite of all three indicators) based on chi-square tests with Bonferroni adjustments for multiple testing.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

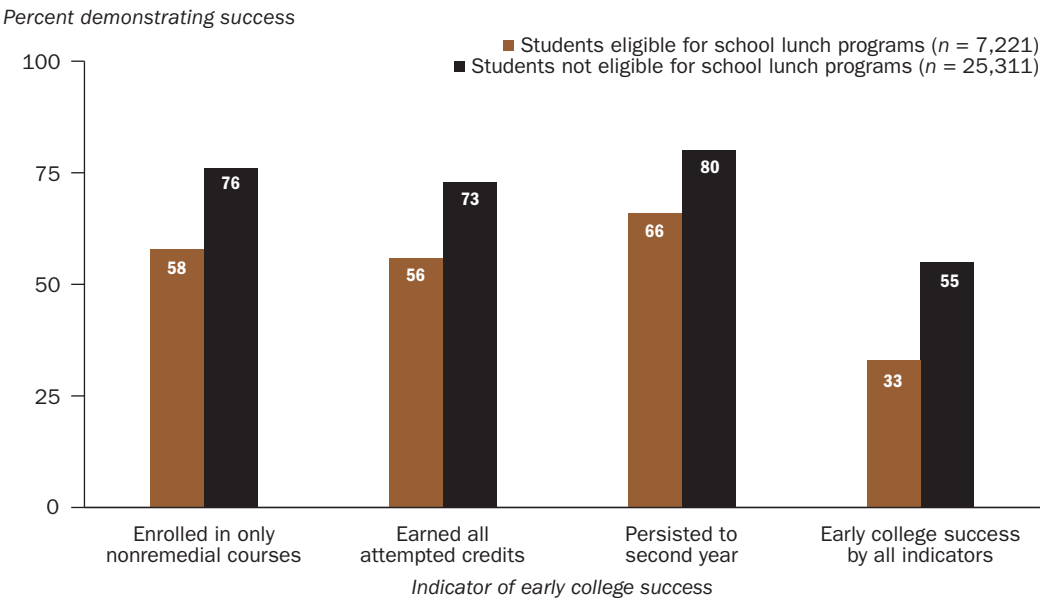
Table C7. The examined predictors explained 35 percent or less of the variance in indicators of early college success, 2010 college freshmen

Indicator	Percentage of variance explained
Students first entering a two-year college[a]	
Enrolled in only nonremedial courses	35
Earned all attempted credits	7
Persisted to second year	8
Success by all indicators	31
Students first entering a four-year college	
Enrolled in only nonremedial courses	25
Earned all attempted credits	19
Persisted to second year	22
Success by all indicators	26

a. Includes Vincennes University, a four-year college that has an open-admissions policy and that grants primarily associate's degrees.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

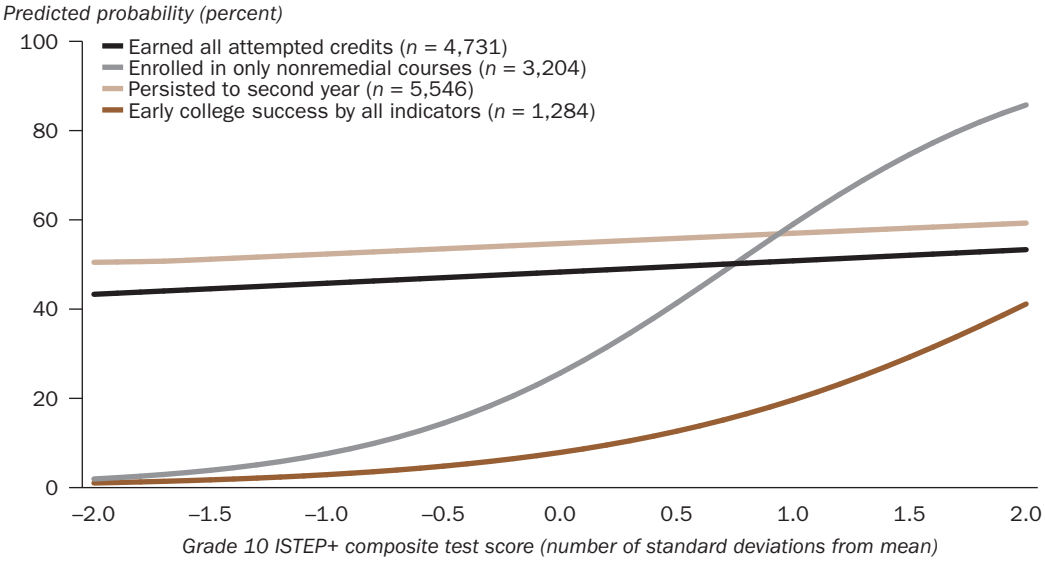
Figure C1. The percentage of students achieving early college success varied by eligibility for school lunch program, 2010 college freshmen



Note: Percentages are unadjusted and do not account for student, high school, or background characteristics.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Figure C2. For a typical student first entering a two-year college, a one standard deviation increase in grade 10 ISTEP+ composite score is associated with a 33 percentage point increase in the predicted probability of enrolling in only nonremedial courses



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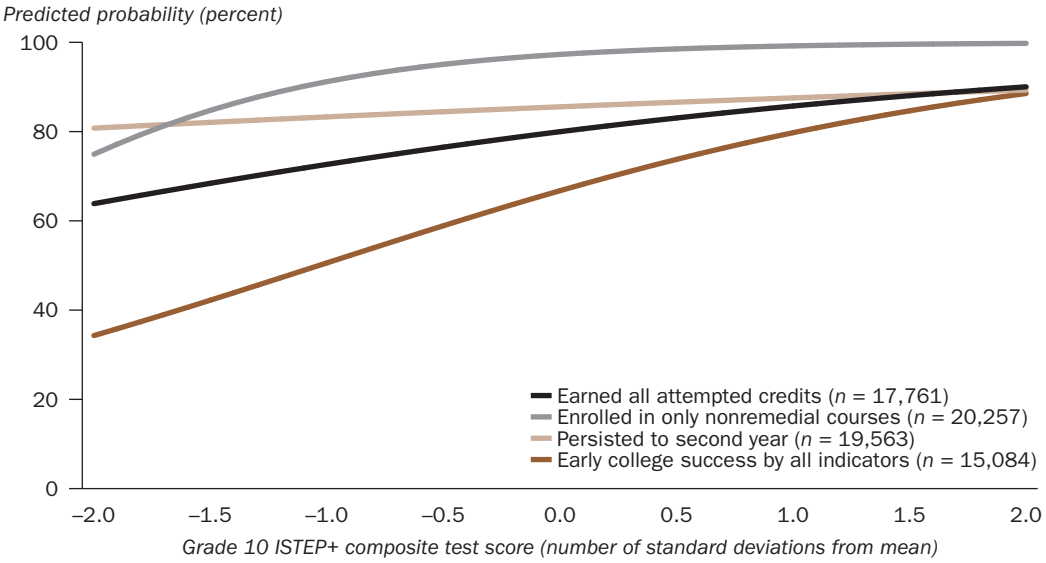
Note: The difference in predicted probabilities accounts for student academic, demographic, and behavioral characteristics; high school academic characteristics; and college type and selectivity characteristics.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Figure C3. For a typical student first entering a four-year college, a one standard deviation increase in grade 10 ISTEP+ composite score is associated with an increase of 13 percentage points in the predicted probability of being college ready by all indicators

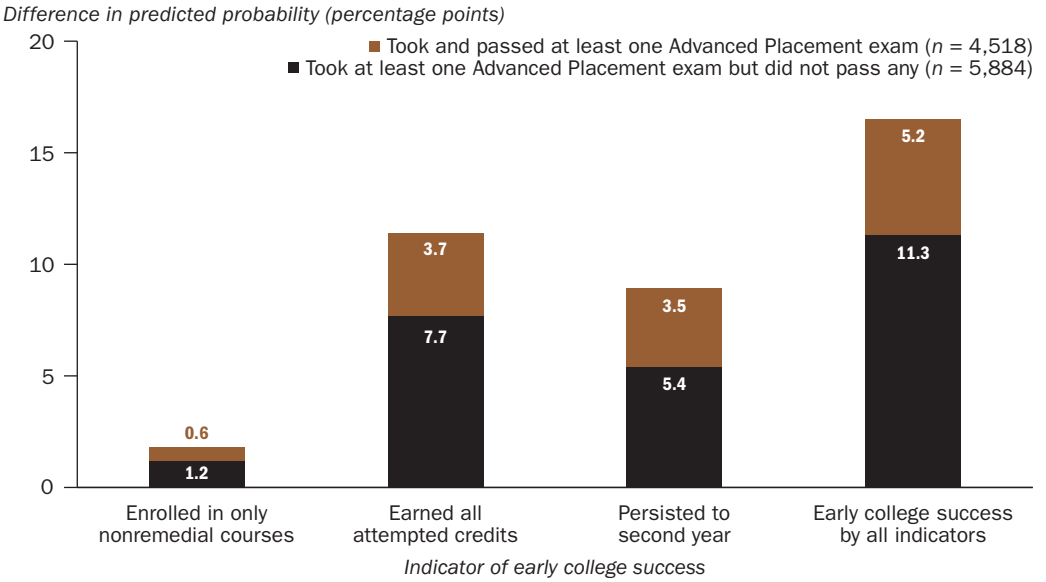


ISTEP+ is Indiana Statewide Testing for Educational Progress—Plus.

Note: The difference in predicted probabilities accounts for student academic, demographic, and behavioral characteristics; high school academic characteristics; and college type and selectivity characteristics.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

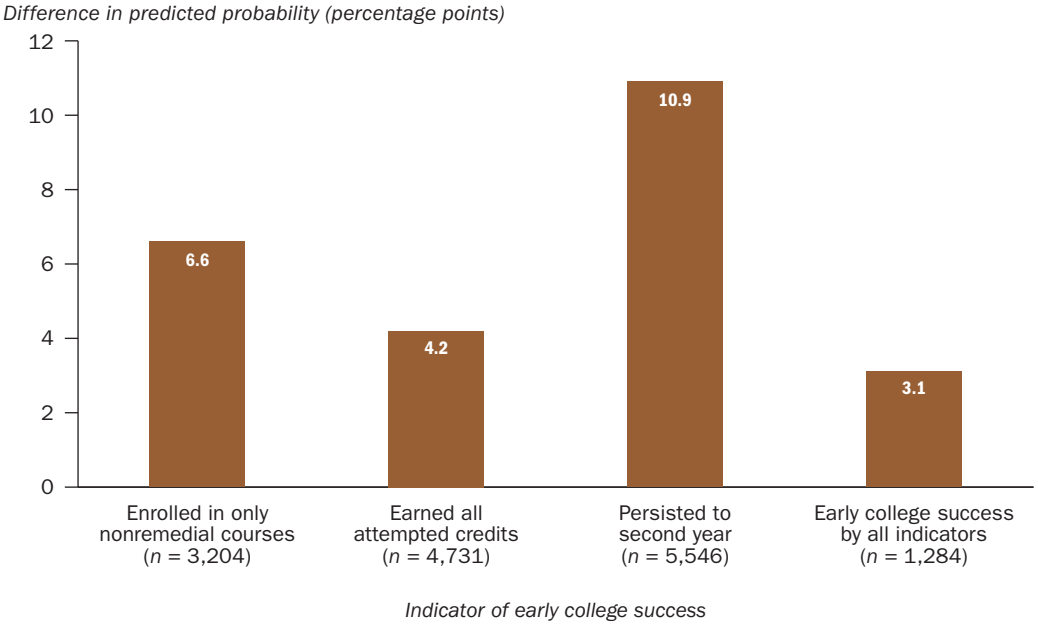
Figure C4. Among students first entering a four-year college, students who took an Advanced Placement exam were more likely than students who did not take these exams to earn all attempted credits, persist to a second year, and have early college success by all indicators



Note: The difference in predicted probabilities accounts for student academic, demographic, and behavioral characteristics; high school academic characteristics; and college type and selectivity characteristics. Percentage points in the brown portions of the bars represent the additional percentage point differences in the predicted probability of each outcome for students who took and passed at least one Advanced Placement (AP) exam, beyond the predicted probability of each outcome for those who took at least one AP exam but did not pass any compared with students who did not take any AP exam.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Figure C5. Students first entering a two-year college who took the ACT or SAT were more likely than students who did not take these exams to have early college success by all indicators

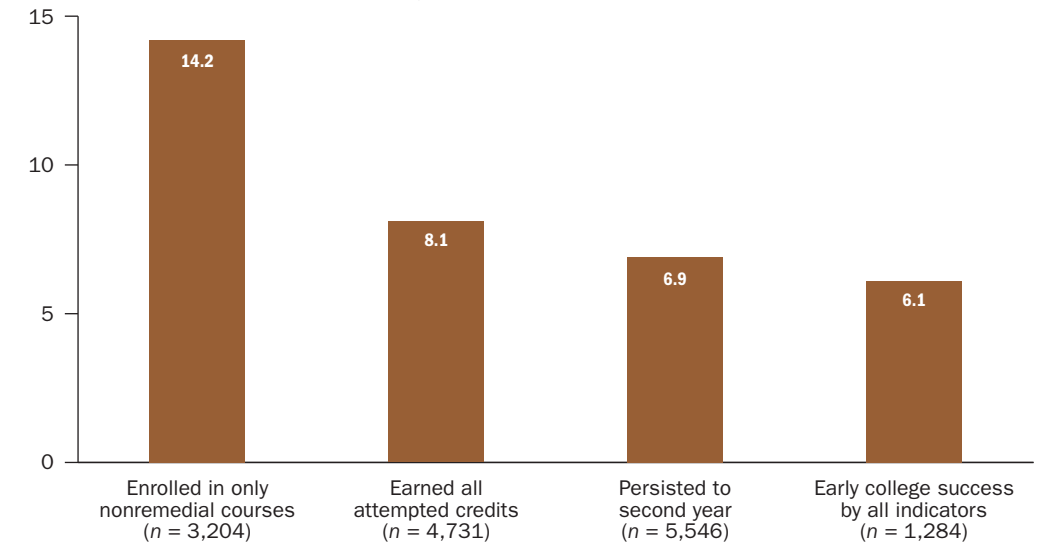


a. Includes students at Vincennes University, a four-year college that has an open-admissions policy and that grants primarily associate's degrees.

Note: The difference in predicted probabilities accounts for student academic, demographic, and behavioral characteristics; high school academic characteristics; and college type and selectivity characteristics.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Figure C6. Students first entering two-year colleges who took an AP exam were more likely than those who did not take any AP exams to have early college success by all indicators



a. Includes students at Vincennes University, a four-year college that has an open-admissions policy and that grants primarily associate's degrees.

Note: The difference in predicted probabilities accounts for student academic, demographic, and behavioral characteristics; high school academic characteristics; and college type and selectivity characteristics.

Source: Authors' calculations based on data from the Indiana state longitudinal data system.

Notes

1. Previous studies have shown differences in postsecondary achievement on the basis of race/ethnicity, socioeconomic status, and gender (see appendix A). Analyses involving diploma type were conducted to shed light on differences in early college success by type of diploma.
2. For students entering a two-year college, there was little variability in whether students passed at least one AP examination. A separate variable was created for two-year college students to show whether they took at least one AP exam, regardless of whether they passed it.
3. For the analyses of students first entering a two-year college, an indicator was included to identify students who entered Vincennes University, which is a four-year college with an open-admission policy that grants primarily associate's degrees. It is combined with two-year colleges to be consistent with Indiana Commission for Higher Education reporting and the university's primary mission as an open-access college, but it may differ from public two-year colleges in structure or the types of students served.
4. ISTEP+ composite scores were standardized across all 2010 Indiana high school graduates. Composite scores were calculated by separately standardizing the math and English language arts scores, summing the result, and then standardizing the sum. The mean standardized ISTEP+ composite score was 0.4 standard deviation less than the entire population for students first entering a two-year college and 0.5 standard deviation higher than the entire population for students first entering a four-year college.
5. A one standard deviation increase in grade 10 ISTEP+ math score equals 64 points, and a one standard deviation increase in grade 10 ISTEP+ English language arts score equals 45 points.
6. Act Inc. lists states that require the ACT on its website (http://www.act.org/stateservices/index_ie.html).
7. This does not imply that these measures are unrelated. For example, the timely completion of a postsecondary credential, without delays from enrolling in remedial coursework, could result in a quicker path to upward mobility.
8. For example, Ivy Tech Community College in Indiana requires students to take the COMPASS skills assessment in writing, reading, and math to determine course placement (http://www.ivytech.edu/compass/placement.html). The University of Southern Indiana uses the Accuplacer exam to determine course placement in math and a student's SAT Critical Reading score, ACT Reading score, or transfer credit to determine placement in reading (scores from a placement exam are used if a student does not have this other information; http://www.usi.edu/acadskil/placement.asp).
9. The SAT also has subject-specific college-readiness benchmarks, equal to 500 points, for the critical reading, math, and writing sections.
10. The purpose and methods of this study are related to but not the same as the purpose and methods of the ACT and SAT college readiness benchmarks. Beyond a better understanding of the relationship between precollege characteristics and college achievement, this report aims to describe and better understand the relationship between different measures of early college success and a variety of precollege student characteristics as well as high school characteristics and college selectivity. The proposed research does not aim to create a single benchmark based on one precollege student characteristic. Moreover, this study used a different sample of students, which is both more narrow (Indiana students) and also more inclusive (the sample includes students who do not take a college admissions exam). Because this study

uses characteristics measured at multiple levels (student, high school, and college), it employs a different statistical technique—hierarchical modeling instead of logistic regression.

11. The National Center for Education Statistics attainment rates described in this paragraph refer to rates for first-time, full-time degree seekers who complete a bachelor's degree within six years of first entering a four-year college or a certificate or associate's degree within 150 percent of normal time for students first entering a two-year college.
12. According to the Vincennes University website, 216 degrees are offered, 93 percent of which are associate's degrees (http://catalog.vinu.edu/content.php?catoid=12&navoid=757).
13. As the number of statistical comparisons increases, the likelihood of finding a statistically significant difference when one does not actually exist also increases. The Bonferroni adjustment is a conservative approach to account for multiple comparisons. A Bonferroni-adjusted *p*-value is the minimum of 1 and the unadjusted *p*-value multiplied by the number of statistical comparisons made (in this case equal to the number of chi-square tests). The Bonferroni-adjusted *p*-values can then be compared with the standard cutoff values for statistical significance (that is, .05, .01, and .001) to assess the statistical significance of each comparison.
14. The within-cell sample size is the number of students within each cell defined by the cross-classification of high school and college. Many of these cells are empty, as not all colleges draw students from all high schools. Cell sizes range from 0 to 204.

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